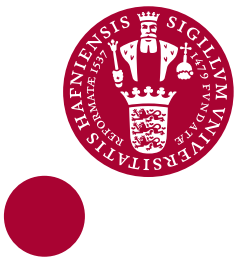

Potential Natural Vegetation of Eastern Africa (Etiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Volume 8

Atlas and Tree Species Composition for Kenya

Kindt, R.; van Breugel, Paulo; Lillesø, Jens-Peter Barnekow; Gachathi, F.; Omondi, W.O; Jamnadass, R.; Graudal, Lars

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Volume 8. Atlas and Tree Species Composition for Kenya

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security

CCAFS

R. Kindt, P. van Breugel, J.-P.B. Lillesø, F. Gachathi, W. Omondi, R. Jamnadass and L. Graudal

FACULTY OF SCIENCE
UNIVERSITY OF COPENHAGEN

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Authors
Kindt R, van Breugel P, Lillesø J-PB, Gachathi F, Omondi W, Jamnadass R, and Graudal L.

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Forest & Landscape Denmark
University of Copenhagen
23 Rolighedsvej
DK-1958 Frederiksberg
sl@life.ku.dk
+45-33351500

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Introduction

This book represents **Volume 8** in a eleven-volume series that documents the potential natural vegetation map that was developed by the VECEA (Vegetation and Climate change in East Africa) project. The VECEA map was developed as a collaborative effort that included partners from each of the seven VECEA countries (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia).

- In **Volume 1**, we present the potential natural vegetation map that we developed for seven countries in eastern Africa. In Volume 1, we also introduce the concept of potential natural vegetation and give an overview of different application domains of the VECEA map.
- **Volumes 2** to **5** describe potential natural vegetation types, also including lists of the "useful tree species" that are expected to naturally occur in each vegetation type – and therefore also expected to be adapted to the environmental conditions where the vegetation types are depicted to occur on the map. **Volume 2** focuses on forest and scrub forest vegetation types. **Volume 3** focuses on woodland and wooded grassland vegetation types. **Volume 4** focuses on bushland and thicket vegetation types. In **Volume 5**, information is given for vegetation types that did not feature in Volumes 2 to 4.
- **Volume 6** gives details about the process that we followed in making the VECEA map.
- **Volume 7** shows the results of modelling the distribution of potential natural vegetation types for six potential future climates.
- **Volumes 8 to 11** provide a national atlas for four of the seven VECEA countries (Kenya, Rwanda, Tanzania and Uganda). We also provide a summary of the descriptions and species composition of potential natural vegetation types that occur in the species country.

We strongly encourage users of the VECEA map to get familiarized with all volumes. For example, as Volume 6 provides a detailed account of the process that we followed in creating the VECEA map, we have not repeated these details in the volumes that provide the national atlases.

Erratum (May 18, 2020): Authorships, localities and dates of photographs have been corrected in the figure captions for 9 different photos in volumes 2, 4, 5, 8, 9, 10, and 11.

Volume 2 Forest	Figures 6.1; 6.2; 20.1
Volume 4 Bushland	Figures 4.7; 7.4; 7.5; 7.8
Volume 5 Other	Figures 3.5; 4.2; 5.4
Volume 8 Kenya	Figures 8.1; 8.2; 16.1; 25.7; 26.4; 26.5; 26.6; 28.5; 29.2; 30.4
Volume 9 Rwanda	Figures 7.1; 7.2; 10.1; 14.7; 15.4; 15.5; 15.6; 16.5; 17.2
Volume 10 Tanzania	Figures 8.1; 8.2; 16.1, 26.7, 27.4; 27.5; 27.6; 30.5; 31.2
Volume 11 Uganda	Figures 8.1; 8.2; 11.1; 20.7; 21.4; 21.5; 21.6; 22.5; 23.2

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We also greatly appreciate the comments and suggestions that were made by Paul Smith and Jonathan Timberlake (both of Royal Botanic Gardens Kew) when they reviewed early drafts of volumes 2, 3, 4 & 5.

Thanks to anybody in our institutions who contributed directly or indirectly to the completion of the VECEA vegetation map and its associated documentation. We especially appreciate the assistance by Nelly Mutio (as for organizing logistics for the regional workshop that we organized in 2009 and for assisting in administrative issues), Melita Jørgensen (for desktop publishing), and of Jeanette van der Steeg for helping with the final preparation of the maps for Volume 1.

Thanks to Ann Verdoodt and Eric Van Ranst (both from the University of Ghent) for compiling and sharing thematic soil maps that were derived from the soil of Rwanda (Birasa, E.C., Bizimana, I., Bouckaert, W., Gallez, A., Maesschalck, G., and Vercruysse, J. (1992). Carte Pédologique du Rwanda. Echelle: 1/250.000. Réalisée dans le cadre du projet "Carte Pédologique du Rwanda" (AGCD, CTB). AGCD (Belgique) et MINAGRI, Kigali).

Thanks to Eugene Kayijamahe, Center for Geographic Information System and Remote Sensing at National University of Rwanda for sharing the digital map "Vegetation of Volcanoes National Park" that allowed us to classify in greater detail this part of the VECEA map.

Thanks to UNEP-GEF for funding the Carbon Benefits Project (CBP) through which information was compiled on indicator and characteristic species for The Vegetation Map of Africa (White 1983). (This work led to the publication in 2011 of an Africa-wide tree species selection tool that is available from: *http://www.worldagroforestrycentre.org/our_products/databases/ useful-tree-species-africa)* Thanks to BMZ for funding the ReACCT project in Tanzania through which funding was made available for field verification of the VECEA map around Morogoro (this was essential in preparing the VECEA map as the base map for Tanzania was essentially a physiognomic map.

We are grateful for the assistance provided by Meshack Nyabenge (ICRAF) and Jane Wanjara (ICRAF) for digitization of maps.

Abbreviations

Abbreviation	Full
A	Afroalpine vegetation
B	Afromontane bamboo
Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
Be	Evergreen and semi-evergreen bushland and thicket
bi (no capital)	Itigi thicket (edaphic vegetation type)
br (no capital)	Riverine thicket (edaphic vegetation type, mapped together with riverine forest and woodland)
C	In species composition tables: we have information that this species is a characteristic (typical) species in a national manifestation of the vegetation type
D	Desert
DBH	diameter at breast height (1.3 m)
E	Montane *Ericaceous* belt (easily identifiable type)
f (no capital)	In species composition tables: since this species is present in the focal country and since it was documented to occur in the same vegetation type in some other VECEA countries, this species potentially occurs in the national manifestation of the vegetation type
Fa	Afromontane rain forest
Fb	Afromontane undifferentiated forest (Fbu) mapped together with Afromontane single-dominant *Juniperus procera* forest (Fbj)
Fc	Afromontane single-dominant *Widdringtonia whytei* forest
fc (no capital)	Zanzibar-Inhambane scrub forest on coral rag (fc, edaphic forest type)
Fd	Afromontane single-dominant *Hagenia abyssinica* forest
Fe	Afromontane moist transitional forest
fe (no capital)	Lake Victoria *Euphorbia dawei* scrub forest (fe, edaphic forest type mapped together with evergreen and semi-evergreen bushland and thicket)
FeE	distinct subtype of Afromontane moist transitional forest in Ethiopia
FeK	distinct subtype of Afromontane moist transitional forest in Kenya
Ff	Lake Victoria transitional rain forest
Fg	Zanzibar-Inhambane transitional rain forest
Fh	Afromontane dry transitional forest
Fi	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest
FLD	Forest & Landscape (URL *http://sl.life.ku.dk/English.aspx)*
Fm	Zambezian dry evergreen forest
Fn	Zambezian dry deciduous forest and scrub forest
Fo	Zanzibar-Inhambane lowland rain forest
Fp	Zanzibar-Inhambane undifferentiated forest
Fq	Zanzibar-Inhambane scrub forest
fr (no capital)	Riverine forests (fr, edaphic forest type mapped together with riverine woodland and thicket)
Fs	Somalia-Masai scrub forest (Fs, mapped together with evergreen and semi-evergreen bushland and thicket)
fs (no capital)	Swamp forest (fs, edaphic forest type)
G	Grassland (excluding semi-desert grassland and edaphic grassland, G)
g (no capital)	Edaphic grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, g)
GCM	General Circulation Models
GHG	greenhouse gas
gv	Edaphic grassland on volcanic soils (edaphic subtype, gv)
ICRAF	World Agroforestry Centre (URL *http://www.worldagroforestry.org/*)
IPCC	Intergovernmental Panel on Climate Change
L	Lowland bamboo
M	Mangrove

P	Palm wooded grassland (physiognomically easily recognized type)
PROTA	Plant Resources of Tropical Africa (URL *http://www.prota.org/*)
S	Somalia-Masai semi-desert grassland and shrubland
PNV	Potential Natural Vegetation
s (no capital)	Vegetation of sands (edaphic type)
SRES	Special Report on Emissions Scenarios
T	*Termitaria* vegetation (easily identifiable and edaphic type, including bush groups around *termitaria* within grassy drainage zones)
UNEP	United Nations Environment Programme (URL *http://www.unep.org/*)
VECEA	Vegetation and Climate Change in Eastern Africa project (funded by the Rockefeller Foundation)
Wb	*Vitellaria* wooded grassland
Wc	*Combretum* wooded grassland
Wcd	dry *Combretum* wooded grassland subtype
Wcm	moist *Combretum* wooded grassland subtype
WCMC	World Conservation Monitoring Centre (URL *http://www.unep-wcmc.org/*)
wd (no capital)	Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type)
We	Biotic *Acacia* wooded grassland
Wk	Kalahari woodland
Wm	Miombo woodland
Wmd	Drier miombo woodland subtype
Wmr	Miombo on hills and rocky outcrops subtype
Wmw	Wetter miombo woodland subtype
Wn	north Zambezian undifferentiated woodland and wooded grassland (abbreviation: undifferentiated woodland)
Wo	Mopane woodland and scrub woodland
wr (no capital)	Riverine woodland (edaphic vegetation type, mapped together with riverine forest and thicket)
Wt	*Terminalia sericea* woodland
Wvs	*Vitex - Phyllanthus - Shikariopsis (Sapium) - Terminalia* woodland (not described regionally)
Wvt	*Terminalia glaucescens* woodland (not described regionally)
Wy	Chipya woodland and wooded grassland
X	Fresh-water swamp
x (no capital)	In species composition tables: we have information that this species is present in a national manifestation of the vegetation type
Z	Halophytic vegetation
ZI	Zanzibar-Inhambane coastal mosaic (Kenya and Tanzania coast)

Contents

1. The rationale of the VECEA map

The VECEA map of eastern and southern Africa (Ethiopia, Kenya, Uganda, Rwanda, Tanzania, and Zambia) is the product of a project funded by The Rockefeller Foundation and implemented by Forest and Landscape Denmark, World Agroforestry Centre, Nairobi, and botanical experts in the seven countries. The project also benefited from previous support to botanists at the relevant departments at the universities of Makerere/Dar es Salaam by an ENRECA programme provided by Danida and previous support to Ethiopian Flora Project provided by SIDA/SAREC and through grants from the Carlsberg Foundation.

The documentation of the VECEA vegetation map consists of seven volumes. In this volume 1, we present the map, and we briefly discuss the important concepts utilised and applied in the map. In volumes 2 to 5, we provide a detailed documentation and discussion of the five major physiognomic vegetation categories and their variation in vegetation types as well as distribution of tree species in this framework. In volume 6, we describe the original maps that we have utilised for each country and we document and discuss the modelling procedures and processes. In volume 7, we model how vegetation types may develop under different climate change scenarios.

So why did we chose to make a regional vegetation map when similar maps have already been developed (Olson *et al*., 2001; Whittaker *et al*, 2005)? The most recent is the ecoregional approach developed by World Wildlife Fund (WWF), Nature Conservancy, and Conservation International. In WWF's terrestrial ecoregion scheme[1], White's vegetation map (and memoir) of Africa (White, 1983) - henceforth called the White map - serve as the basis for the ecoregions of the Afrotropics (Olson *et al*; 2001; Burgess *et al*. 2004). In this process the ecoregions map has mainly become a simplified version of the White map. A major objective of the White map is to provide a framework on a continental scale within which more detailed local studies can be conducted and compared and as such the map is suitable as a basis for describing the terrestrial ecoregions of Africa by capturing the broad-scale patterns of biological diversity and the ecological processes that sustain them.

We have taken the opposite approach of WWF's terrestrial ecoregion scheme by deconstructing[2] the White map into its more detailed parts. We have done this by utilising the same smaller maps as those that White utilised and to a large extent described in his text without directly mapping them. The VECEA map thus differs in terms of the spatial resolution, which allows us to break down the landscape into more well defined mapping units.

So why do we think that a higher resolution of the map is important? It is in the nature of the scale of the White map (1:5,000,000) that vegetation units on the map are heterogeneous in character and only broadly delineated and thus it is not possible to utilise the White map for a more detailed understanding of vegetation dynamics and species distributions, which is an understanding that is required if a map should be of importance for field

1: See also *http://www.worldwildlife.org/science/ecoregions/ecoregion-conservation.html*

2: Our method can best be described by paraphrasing the term deconstruction (Derrida, 1967). The White map is an interpretation of reality and we explain it and provide a higher resolution map by revisiting the maps and botanical research that he used to make his map. The VECEA map is thus also an interpretation of reality, but at a higher resolution.

implementation (see below for the intended uses of the VECEA map). Furthermore for practically all indigenous species in the region there is insufficient point location data available to make good estimates of their actual and potential distributions across landscapes. A higher resolution of maps and consequently more detailed predictions of species distribution, however, opens up a new discussion of how to interpret vegetation dynamics at the community level (see below for our discussion of Potential Natural Vegetation), but this discussion is unavoidable and necessary for successful field implementation. The great advantage of mapping at a higher resolution is that the interpretation of community dynamics becomes publicly available and can be disputed and tested. This is in contrast to ecoregion maps where managers of restoration projects and tree planters must make their own guesses based on very generalised recommendations.

In comparison with White, we have had the advantage of computer based technologies that has enabled us to provide a higher resolution for a very large geographic area. Based on our analysis, we are in overall agreement with White's methodology and approach and we will provide a detailed discussion of the VECEA map in a number of peer reviewed papers. The process of elaborating the regional map has been iterative. Almost all available relevant vegetation information for the VECEA countries from early 20th century and onwards were collated and digitised. The botanists prepared national maps based on their interpretation of available vegetation maps and botanical information. The preparation of the regional map was a process of harmonisation of nomenclature and interpretation of vegetation types in an interaction between the team members.

The main objective for preparing the map is utilitarian and closely related to the requirement for a more detailed understanding of the indigenous tree species in the region – to improve the productivity of smallholder tree growers utilising the species in agroforestry systems. The utility of the map, however, goes beyond understanding the productivity of indigenous tree species and encompasses a more general understanding of agricultural productivity and conservation of fauna and flora in ecosystems.

In summary, the utility of the VECEA vegetation map, complemented with additional information on vegetation development and other environmental data layers, is that it:

(i) provides an integrated interpretation of landscapes and indicates the position of transitions between areas with significantly different environmental conditions, conditions which are most likely to be important determinative factors for agricultural potential;
(ii) predicts potential distributions of indigenous plant species in the agricultural landscapes and predicts possible genetic variation across distributional ranges;
(iii) can be a tool for predicting potential distributions of species of terrestrial animals, birds, reptiles, and invertebrates in remaining natural vegetation;
(iii) can be a user friendly extension tool for improving the potential

options (both from indigenous and exotic species) available to farmers in their quest for improving livelihoods and income generation;

(iv) provides for possible forecasts of changes in agricultural potential resulting from climate change;

(v) provides a management tool for interpretation of historical, current, and future distribution of ecosystems and ecoregions, including alternative stable states;

(vi) provides a tool for ecological restoration and protection of ecosystems.

2. Definition of forest, woodland, wooded grassland, bushland and thicket

Forests are continuous stands of trees at least 10 m tall with interlocking crowns (White 1983 p. 46). White (1983 p. 46) distinguishes **scrub forests** that are intermediate in structure between forest and bushland (and thicket). They are usually 10 - 15 m high. Trees (woody plants with well-defined and upright boles) are usually present but do not form a closed canopy. Smaller woody plants (principally bushes and shrubs) contribute at least as much as the trees to the appearance of the vegetation and its phytomass.

Woodlands are open stands of trees of at least 8 m tall with a canopy cover of 40 percent or more(1), but never with interlocking crowns and usually with a field layer of heliophilous ('sun-loving') grasses. Woodlands have similar height as **forests**, but woodlands never have densely interlocking crowns (although the crowns can be in contact). White (1983 p. 46) distinguishes **scrub woodlands** that are intermediate in structure between woodland and bushland, being stunted variants (< 8 m) of main woodland vegetation types (i.e. containing the same dominant tree species).

Bushlands are open stands of bushes (usually between 3 and 7 m tall) with a canopy cover of 40 percent or more. **Thickets** are closed stands of bushes (usually between 3 and 7 m tall) where the bushes are so densely interlaced that they are impenetrable - except along tracks made by animals. Bushlands and thickets are taller than **shrublands** defined as open or closed stands of shrubs up to 2 m tall (White 1983 p. 46).

Wooded grasslands are lands covered with grasses and other herbs with woody plants (trees [≥ 7 m tall], bushes [3 - 7 m], dwarf trees, palm trees or shrubs [≤ 2 m]) covering between 10 and 40 percent of the ground. Woody plants nearly always occur scattered (White 1983 pp. 46, 47 and 52).

Grasslands are defined as lands covered with grasses and other herbs and where woody plants do not cover more than 10% of the ground (White 1983 p. 46).

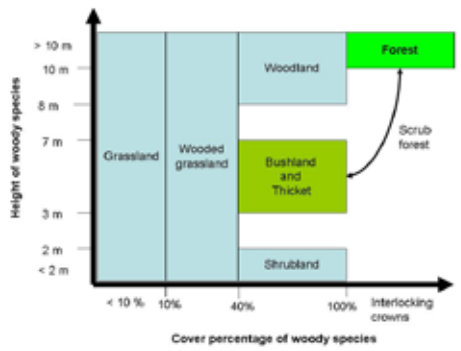


Figure 1. Height and cover percentage limits for major physiognomic types. Scrub forest is defined as a physiognomic mosaic of forest and bushland and thicket

3. What is potential natural vegetation?

We will here attempt to clarify how we interpret and implement terms utilised in the classification of vegetation. The central concept "Potential Natural Vegetation" in the VECEA map can be seen as the pivot around which a whole range of contested assumptions circle. These unavoidable assumptions are concerned with the distribution and dynamics of species and vegetation. While it is indisputable that plants are not randomly distributed geographically and in time, there is an ongoing debate about at what scale patterns can be discerned and whether plant species form assemblies that follow similar distribution patterns.

Friis (1998) in his review of the development of chorology explains that one of the earliest disputes in botany was about classifying plant distributions (plant chorology). In the beginning of the 19th century J.F. Schouw divided the globe into areas with more or less defined floras. Some of the most important criteria were based on presence or absence of characteristic species and without making assumptions about the historical development of the flora. Some twenty years later in a large work on plant geography A. de Candolle completely rejected a natural classification of the world into phytochoria because. (i) the plant world was too poorly known, and (ii) scientists did not apply sufficiently logical criteria. During the following century many scholars further contributed to the understanding of plant chorology in Africa and there is now a general consensus on chorology as a useful tool to describe plant species distributions in Africa - contrary to the situation in Europe (Friis, 1998). Frank White has been a major contributor and chorological patterns are an important integral part of White's vegetation map. Although logical, the criteria utilised are still not completely objective in the strictest sense. As Friis points out, White more than once stated that "there is no *a priori* reasons why the pattern lines on a vegetation map based on physiognomy of vegetation should coincide closely with those of a chorological map based on the coinciding distributional limits of species." But the results of his work with the vegetation map of Africa showed that if the chorological map of Africa was based on chorological data alone, rather than on transferring pattern lines from a detailed vegetation map, the pattern lines would not have been significantly different" (Friis, 1998 p. 37).

Early concepts concerned with the definition of community patterns in space are the biome[3], that was introduced to plant ecology by Clements in the first half of the 20th century and ecoregion that was introduced by Crowley, and Bailey in the second half of the same century (see discussion in Pennington *et al.,* 2004). The concepts are largely overlapping and assume that one can discern broad scale patterns in the distribution of ecological communities, which are defined by similar climax plant formations and environmental conditions. A major difference is that an ecoregion is never discontinuous, while a biome is in principle always coincident with the climax vegetation and therefore can consist of disjunct areas (Bailey, 2005). Biomes

3: Biome, also called major life zone, the largest geographic biotic unit, a major community of plants and animals with similar life forms and environmental conditions. It includes various communities and is named for the dominant type of vegetation, such as grassland or coniferous forest. Several similar biomes constitute a biome type - for example, the temperate deciduous forest biome type includes the deciduous forest biomes of Asia, Europe, and North America. "Major life zone" is the European phrase for the North American biome concept (*http://www.britannica.com*, accessed November 14, 2011).

and ecoregions define very large scale patterns, thus allowing for analysis at a continental or global scale, and are widely used by conservation agencies.

During the first part of the 20th century Clement and later Tansley[4] envisaged that in a given area, the assemblage of plant species would compete and replace each other such that eventually the dominant species would coexist in a stable climax (equilibrium/balance of nature), which would vary with the biotic and abiotic environment including the prevailing climate. This climax concept was soon after contested by Gleason who saw vegetation development as a stochastic process rather than as development as an organism, with communities composed of species with individual adaptations to the biotic and abiotic environment and thus with individual distributions. During the almost one hundred years since these ideas were conceived an enormous amount of studies and theoretical developments have modified our understanding of vegetation dynamics and it is unlikely that any scholar today would understand the term 'climax vegetation' in the same way as Clement and Tansley did. Already Whittaker (1962) in a review of the field of vegetation classification largely corroborated Gleason's view. This concept of the flux of nature led to interest in theories where disturbance is seen as a permanent feature of vegetation such as patch dynamics and patterns and processes in forest (Cadenasso *et al.*, 2003, Whitmore, 1982, van der Maarel, 1996). However, a non-equilibrium view does not preclude that there can be patterns of coinciding distribution of species, such that vegetation types can still be identified (Walker & Del Moral, 2003; Chadzon, 2008).

The concept of Potential Natural Vegetation (PNV) is part of this development of vegetation science. A widely accepted definition of PNV is: Potential natural vegetation has been defined as the vegetation structure that would become established if all successional sequences were completed without interference by man under the present climatic and edaphic conditions, including those created by man (van der Maarel, 2005). The term was coined by Tüxen in the middle of the 20th century (Tüxen, 1956) and has been applied in many parts of the world to categorise plant communities. The concept is closely related to the schools of phytosociology, which originated in Europe and elaborated methods for vegetation analysis and detailed and often hierarchical systems of classification of vegetation by floristic and physiognomic characteristics (see reviews by van der Maarel, 2005; Whittaker, 1980). We do not consider the reintroduction of the PNV concept as a statement about the degree of niche assembly of ecological communities versus a stochastic neutral theory (sensu Hubbell, 2008) but as a tangible hypothesis about species distributions.

We believe that there is truth in the concepts of climax and PNV as well as in the critique and that for practical conservation and management of vegetation and species this discussion should not only be a theoretical discussion, but should be lead to a more informed interpretation of 'real' landscapes. The dichotomy between the continuum concept and the concept of communities as co-occurring species can in principle be solved by considering the two concepts as two different and complementary ways of looking at the same landscape (after Austin, 2005, pp. 66-67): The continuum

4: **Ecosystem**, the complex of living organisms, their physical environment, and all their interrelationships in a particular unit of space. The concept of ecosystems, introduced by Tansley, not only considers the complex of living organisms and their physical environment, but also all their relationships in a particular unit of space (*http://www.britannica.com*, accessed November 14, 2011).

concept applies to an abstract environmental space, not necessarily to any geographical distance on the ground or to any indirect environmental gradient. The abstract concept of community of co-occurring species can only be relevant to a particular landscape and its pattern of environmental variables, community is a property of the landscape. Such a community concept is compatible with the different concepts of a continuum. The PNV map thus offers a useful tool in lieu of missing environmental relationships. For the forests we have been careful not to map the detailed variation of the forest types, but have kept the physiognomic and chorological classification of White (1983). As pointed out by Langdale Brown and Omaston "The forests are characterised by a great variety of species and communities. Sometimes edaphic or seral relationships between these types are clear, but we cannot yet account for all the differences. Indeed these tropical forests are such complex and longlived communities that in many cases it is not yet possible to be sure what is the climax; even the very nature and constancy of the climax is in doubt." (Langdale Brown & Omaston, 1964 p. 36).

The 'Clementian' traits of interpreting PNVs are in particular (i) the use of rigid hierarchical systems of classification together with a rigid prescription of species composition, and (ii) a static view that there can be only one endpoint to succession. We suggest that the PNV concept should not be interpreted in terms of a static 'Clementian' paradigm and we have been helped in this by the non-hierarchical classification utilised by White. The largest part of the VECEA region is covered by dry vegetation where fire and large browsers (megaherbivores) have profound influence on vegetation development (Bond *et al.*, 2005, Owen-Smith, 1987) and there may in most cases be more than one stable state for the vegetation of a particular area. The use of PNV can thus be an aid in interpreting the dynamics of vegetation and likely alternative stable states. In the Serengeti-Mara area the possibility of alternative stable states has been convincingly documented (Sinclair *et al.*, 2007, McNaughton *et al.*, 1988, Dublin *et al.*, 1990) and the VECEA map could be a tool for identifying alternative stable states in other areas.

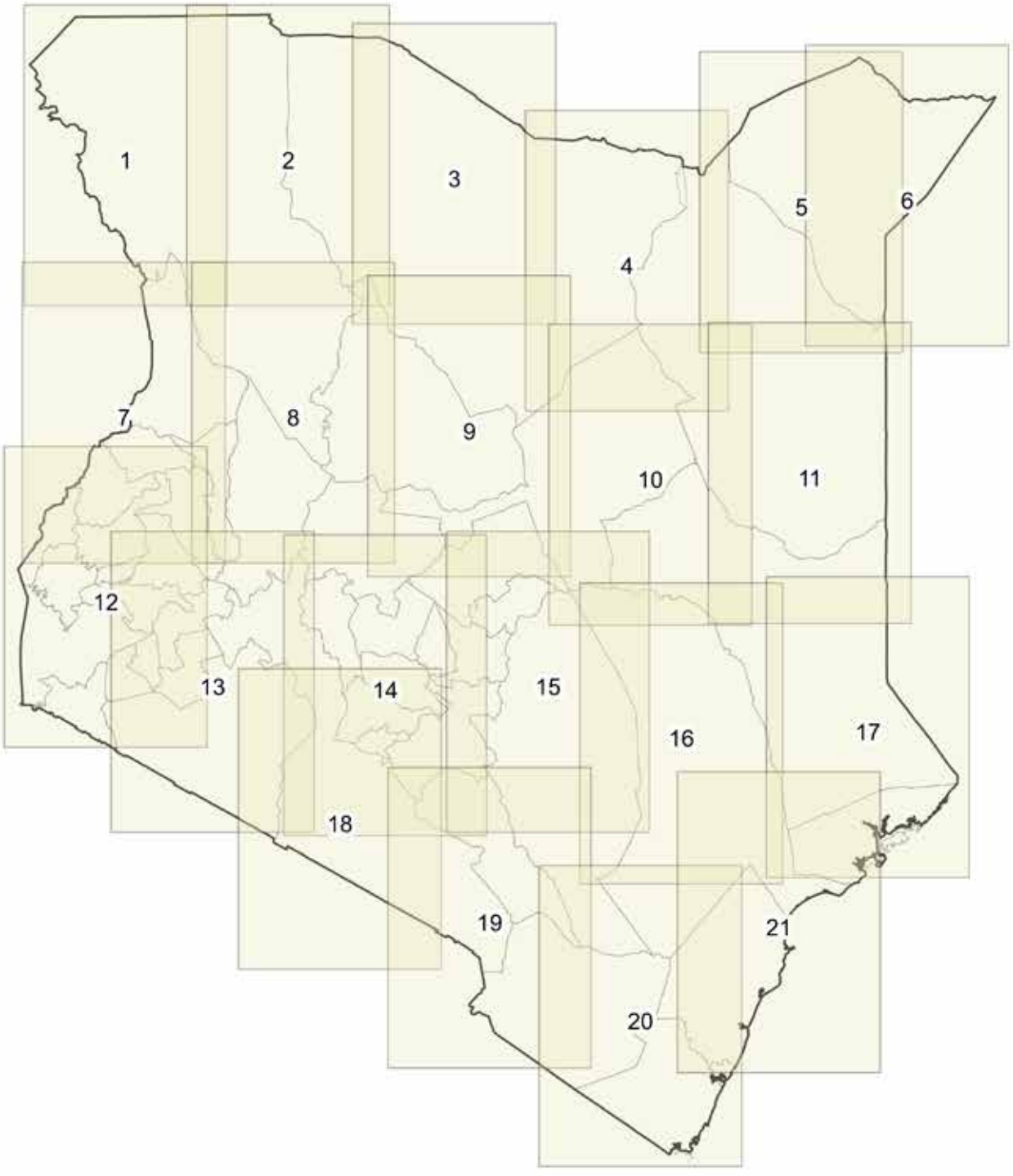
With the VECEA vegetation map we suggest that the interpretation of landscapes is done at such a resolution that the implications of analyses can be transferred directly to the landscapes. In making a map with this level of detail we have entered the domain of the contested concepts (climax, continuum, species assembly rules, non-equilibrium communities, etc), which may otherwise be avoided at the biome/ecoregional level of analysis (but not in the implementation and management of patterns and processes in actual landscapes). We do not claim that we have completely solved the conundrum with our map, but we trust that we have created a tool that can be an aid in biogeographical analyses.

When the concepts, biome, plant community, and PNV are defined very loosely (as they are often used in practice) they are almost interchangeable in the sense that they all attempt to describe the variation in vegetation that can be experienced as one moves through a landscape. The use of the two first concepts is rarely questioned - because of the underlying objectives and the scale at which they are used – as they are rarely utilised in a context

where they need to be applied in a particular landscape. PNV on the other hand, by nature of its use to describe plant communities on large scale, immediately invokes an interpretation of pattern and process. Like the concept of chorology, the concept of PNV is logical, but the criteria utilised can not be completely objective in the strictest sense. This is to us an acceptable compromise, since nature includes a large degree of history and chance and we suggest that the PNVs are tested and corroborated through empirical tests as well as modelling.

The PNV concept offers a tool that can be utilised in analysing the pattern and processes in landscapes including the biotic and abiotic interrelationships that govern these ecosystem aspects. As such it complements and can be used as an input to modelling of ecosystems and individual species. Although we are confident that the VECEA map provides a realistic picture of where particular vegetation types occur, the map still is a hypothesis about what the actual vegetation type will be. This is an inherent consequence of trying to map anything.

4. Maps of Kenya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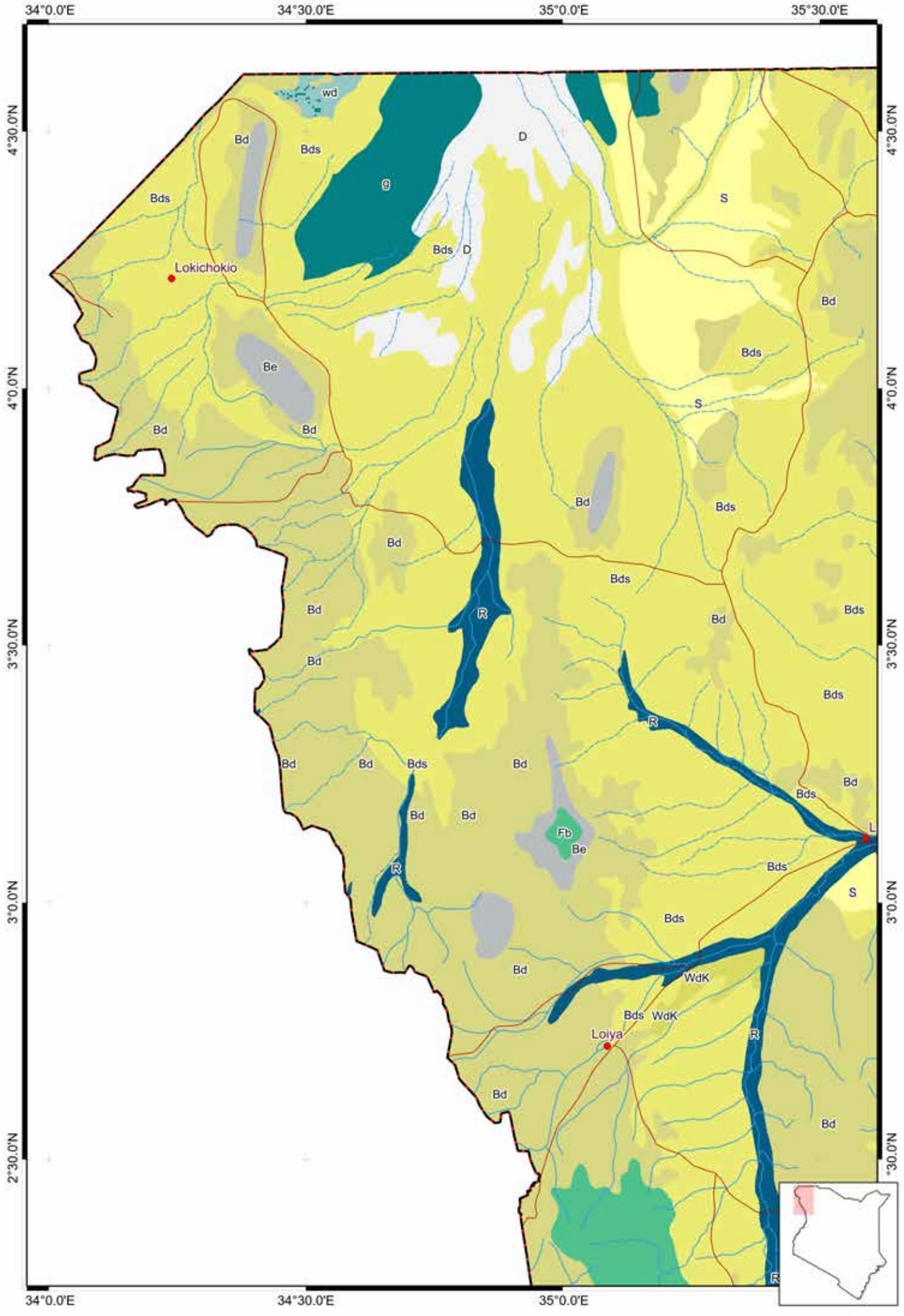
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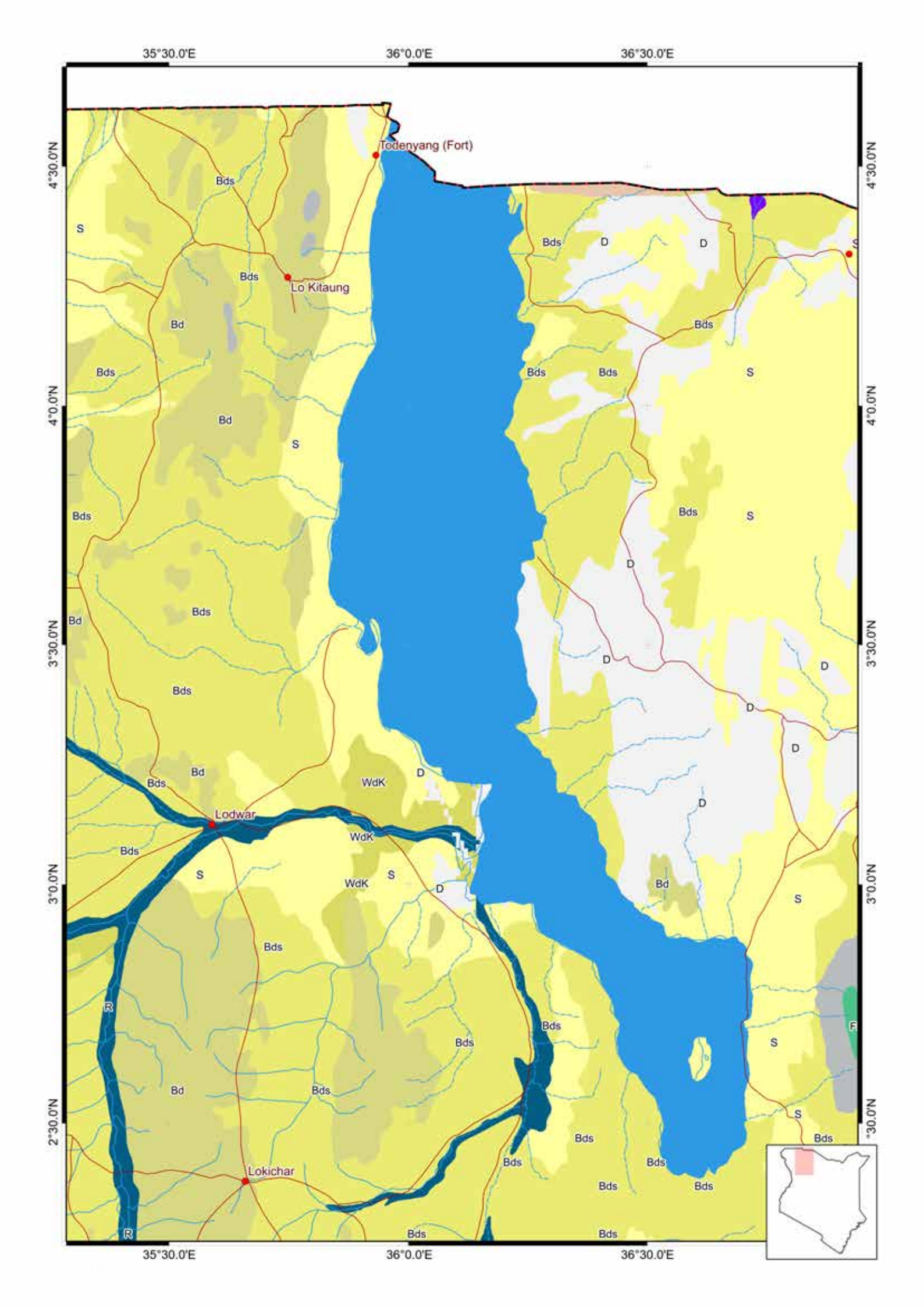
wd
Bd
Bds
g
D
S
Lokichokio
Be
R
Fb
WdK
Loiya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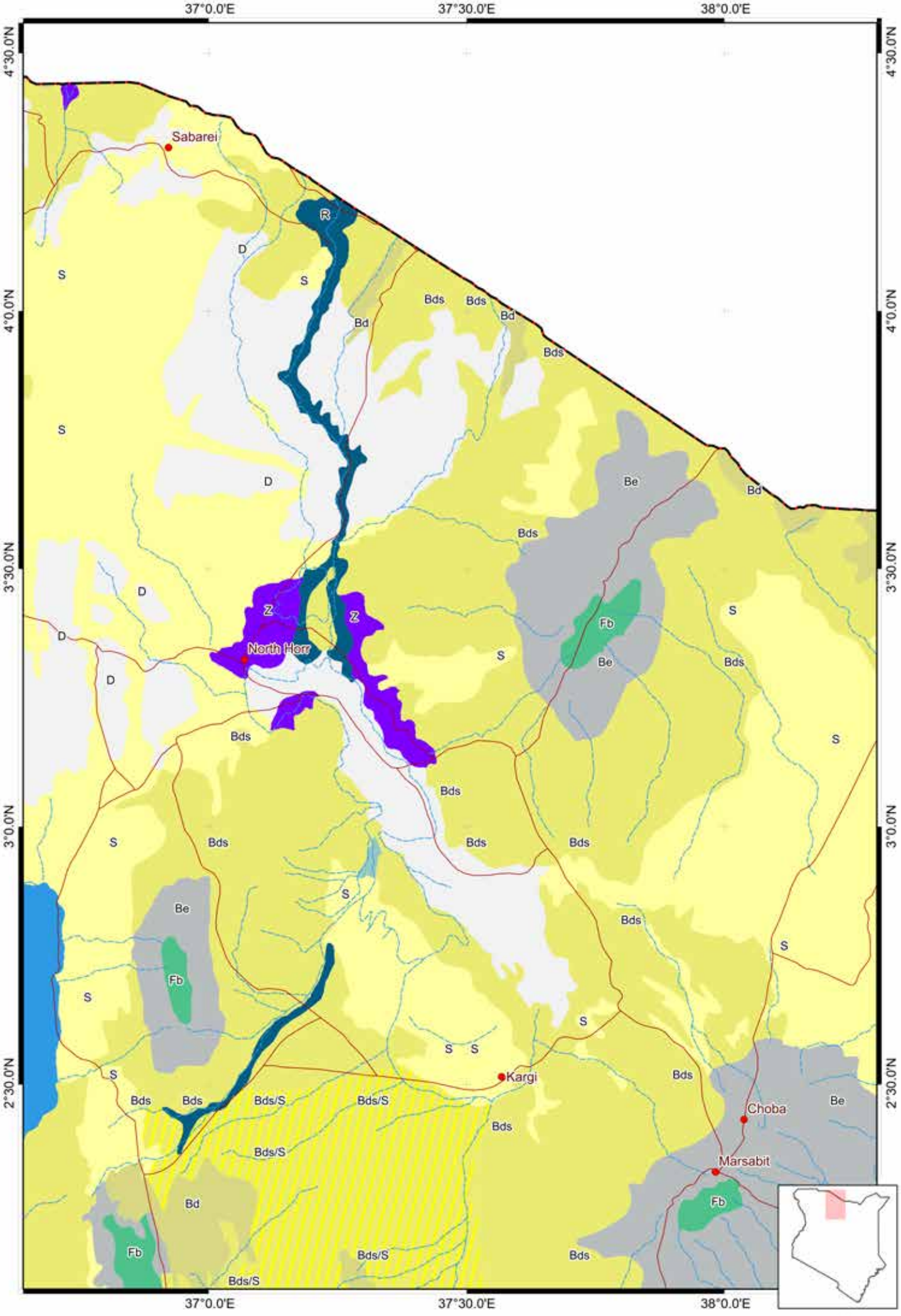
Todenyang (Fort)
Lo Kitaung
Lodwar
Lokichar
Bds
Bd
S
D
WdK
R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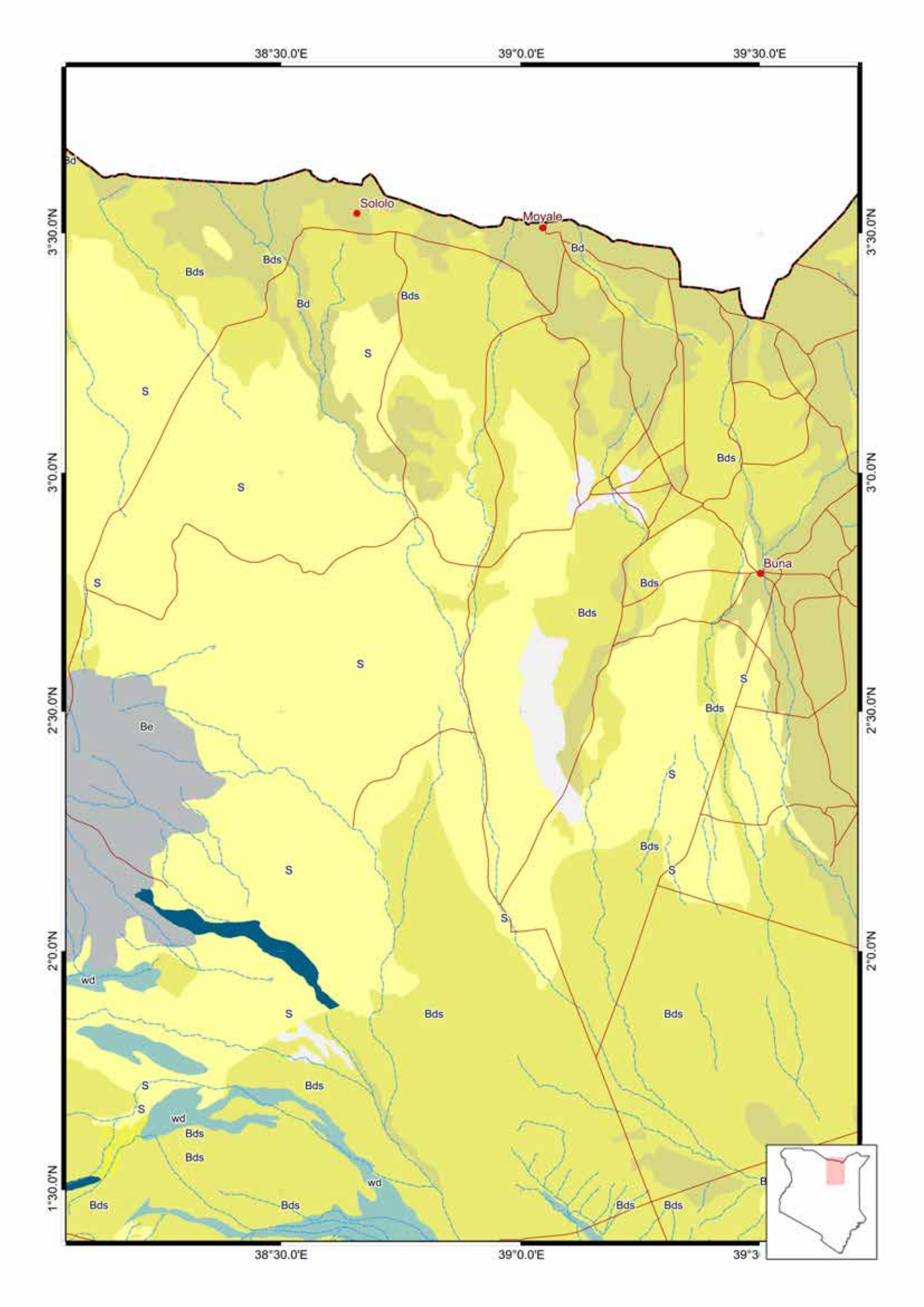
2°30.0'N
Sabarei
North Horr
Kargi
Choba
Marsabit
R
Z
D
S
Bd
Bds
Bds/S
Be
Fb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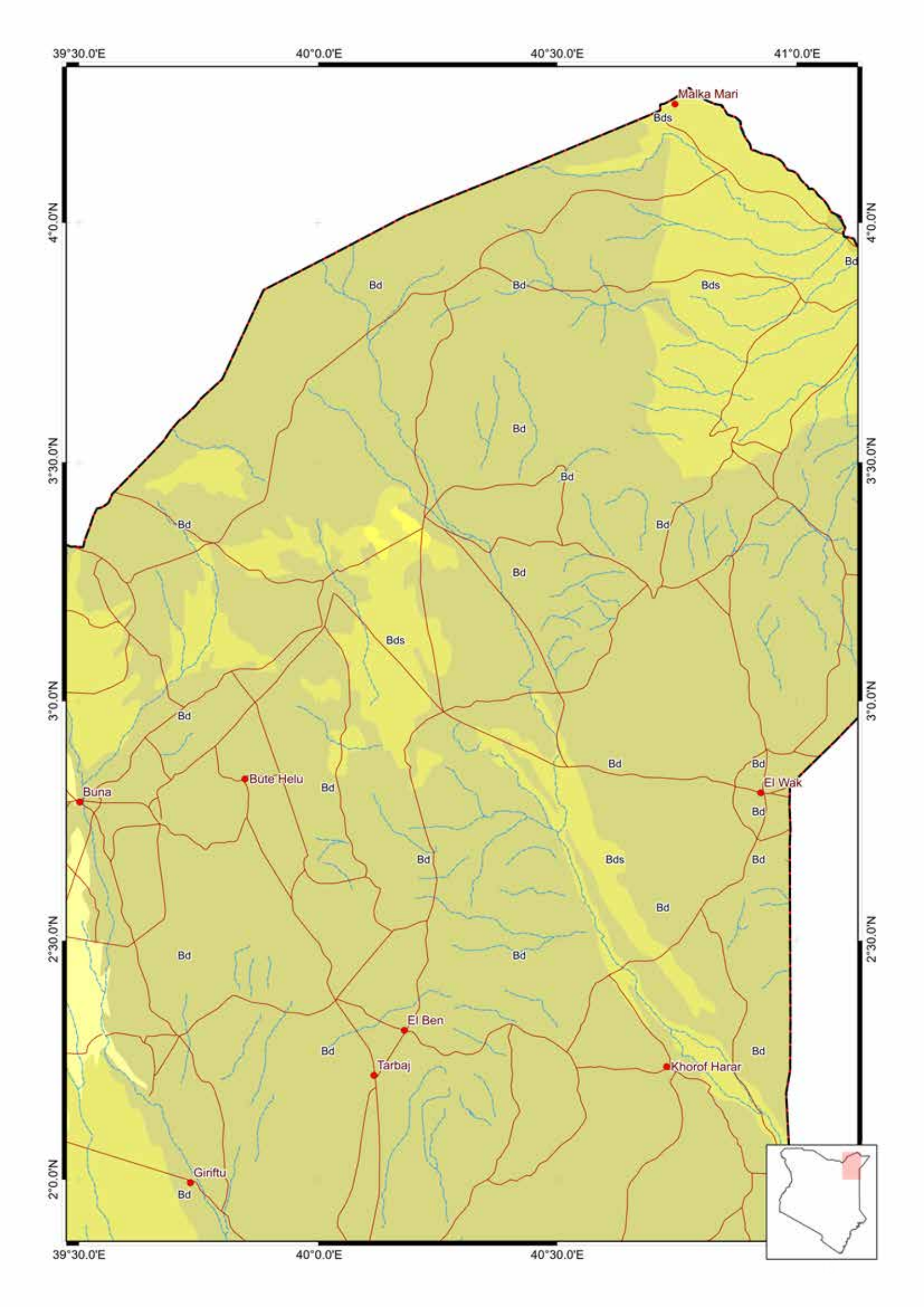
Sololo
Moyale
Buna
Bd
Bds
S
Be
wd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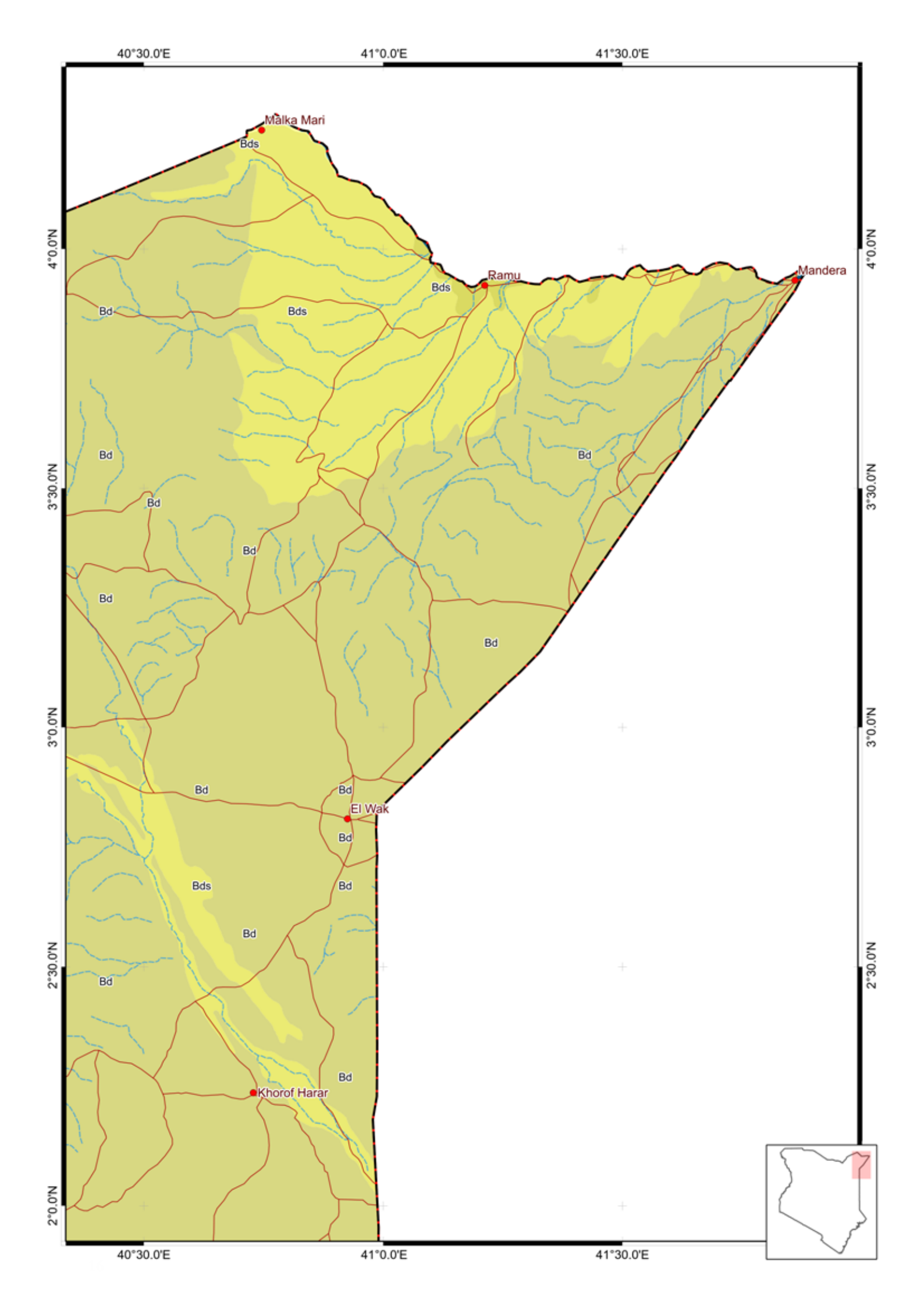
Bds
Bd
Bute Helu
Buna
El Wak
El Ben
Tarbaj
Khorof Harar
Giriftu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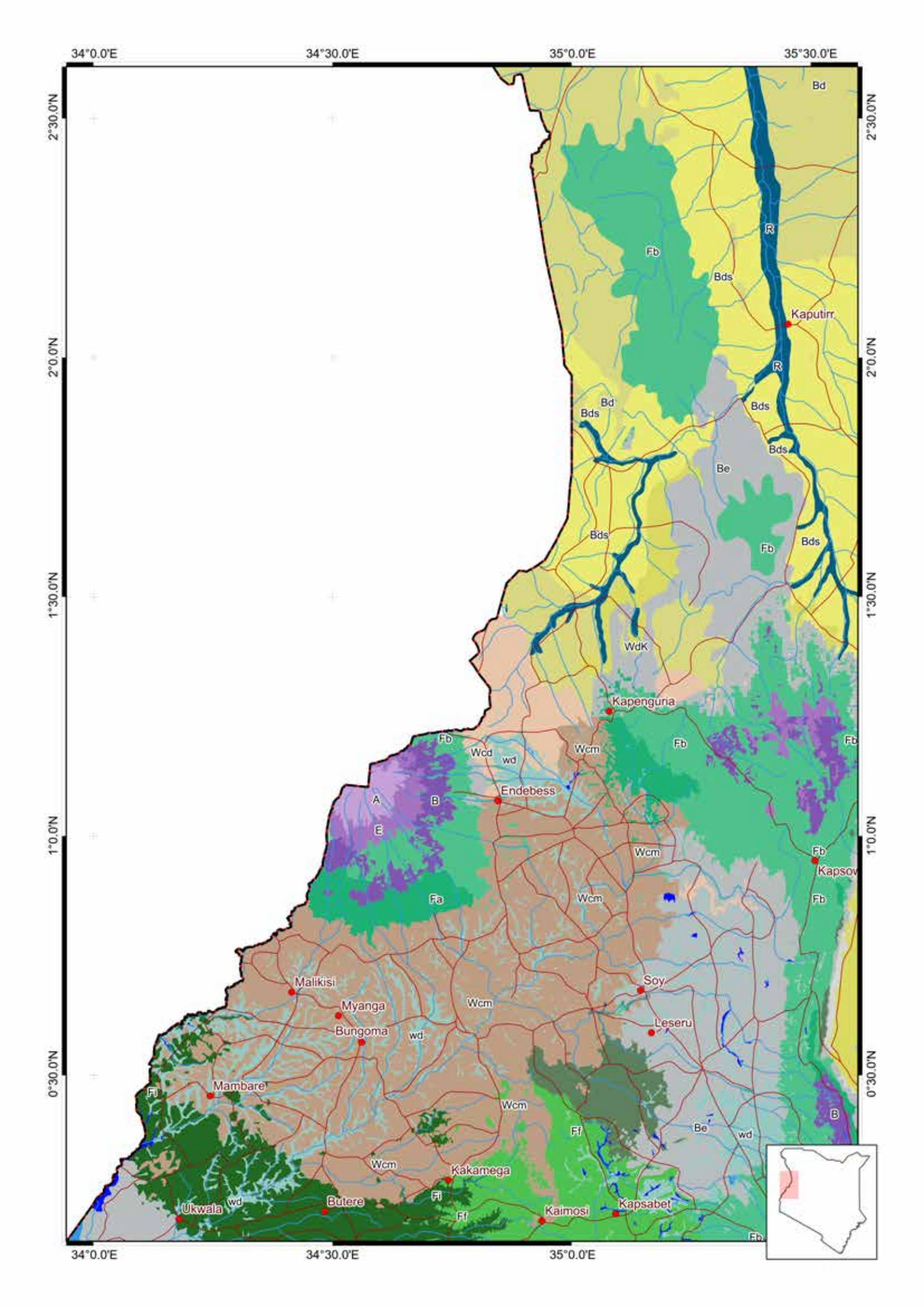
Malka Mari
Ramu
Mandera
El Wak
Khorof Harar
Bd
Bds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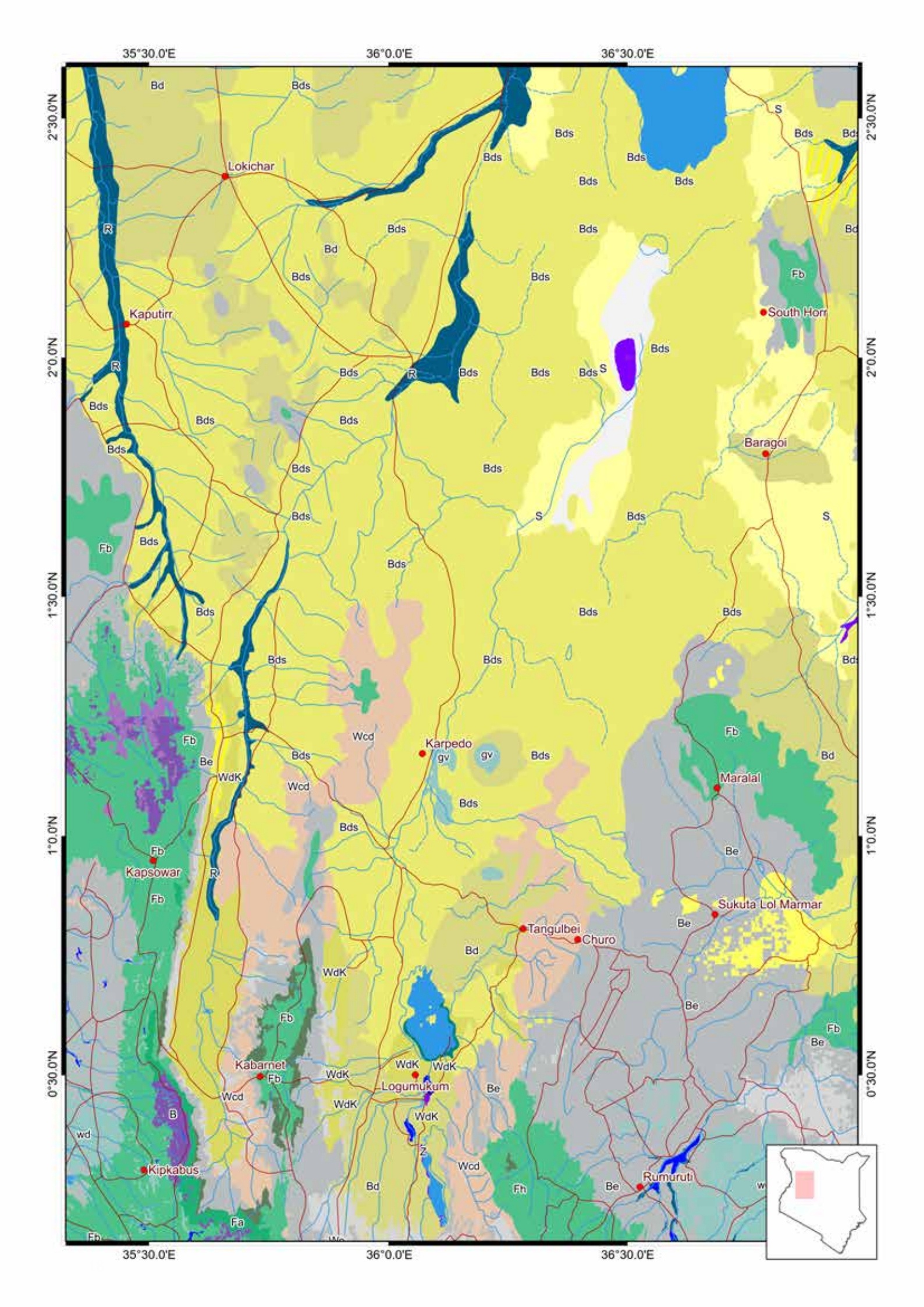
1°0.0'N
0°30.0'N
Bd
R
Fb
Bds
Kaputirr
Be
WdK
Kapenguria
Wcd
wd
Wcm
Endebess
A
B
E
Fa
Kapsov
Malikisi
Myanga
Bungoma
Soy
Leseru
Mambare
Fl
Ff
Kakamega
Ukwala
Butere
Kaimosi
Kapsabet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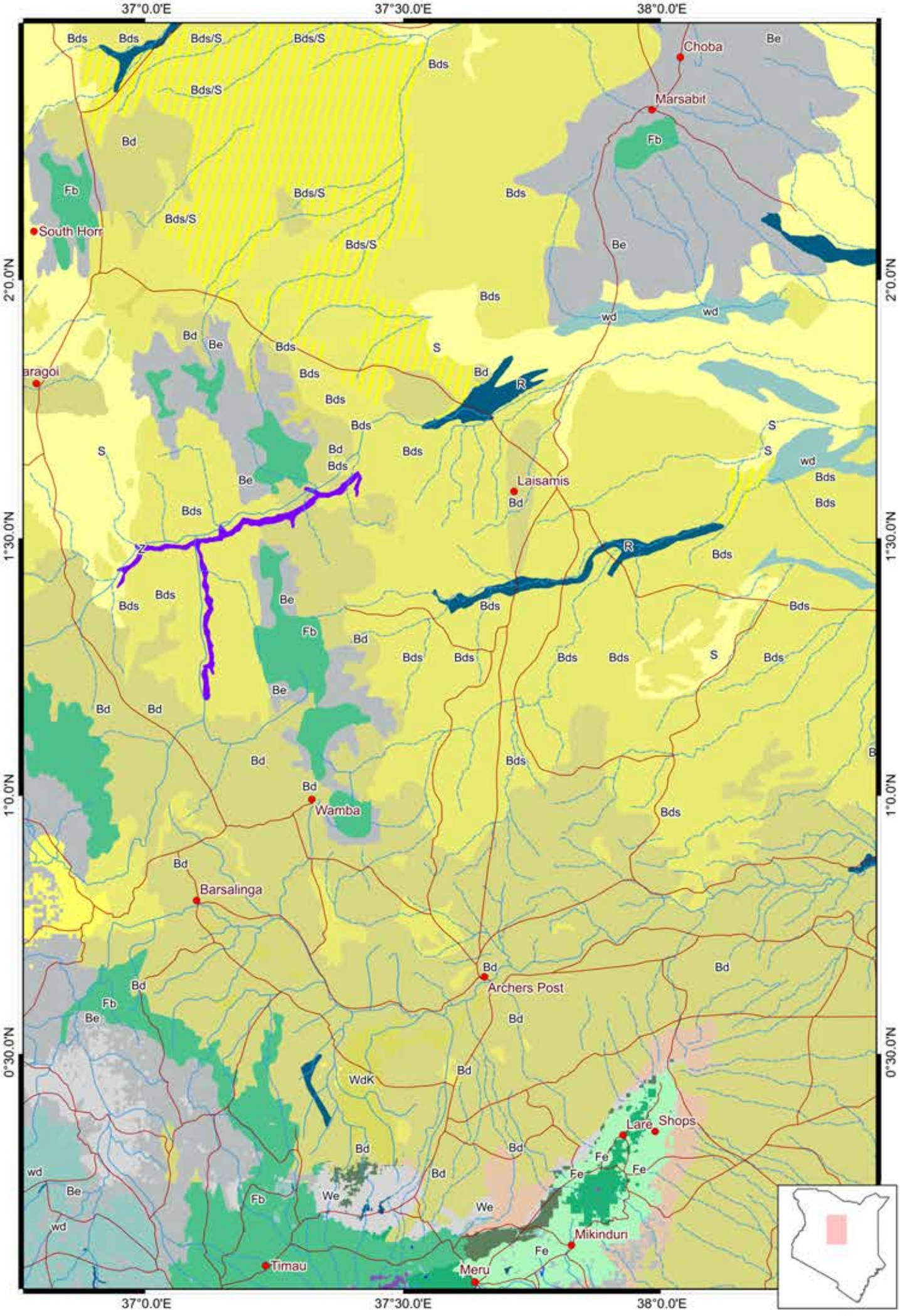
0°30.0'N
Lokichar
Kaputirr
South Horr
Baragoi
Karpedo
Maralal
Kapsowar
Tangulbei
Churo
Sukuta Lol Marmar
Kabarnet
Logumukum
Kipkabus
Rumuruti
Bds
Bd
Be
Fb
Wcd
WdK
gv
R
S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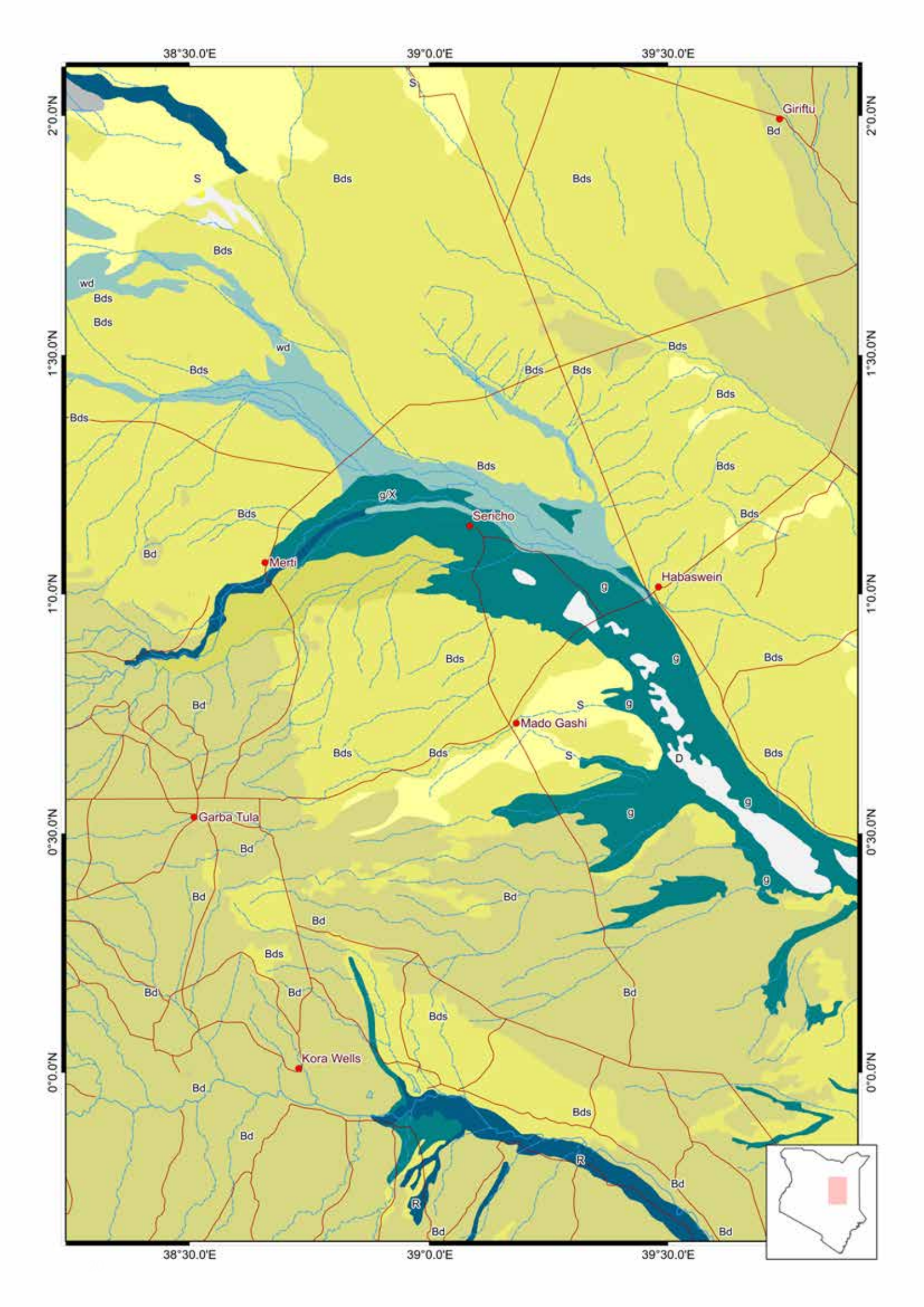
Choba
Marsabit
South Horr
aragoi
Laisamis
Wamba
Barsalinga
Archers Post
Lare
Shops
Mikinduri
Meru
Timau
Bds
Bds/S
Bd
Be
Fb
S
R
wd
WdK
We
Fe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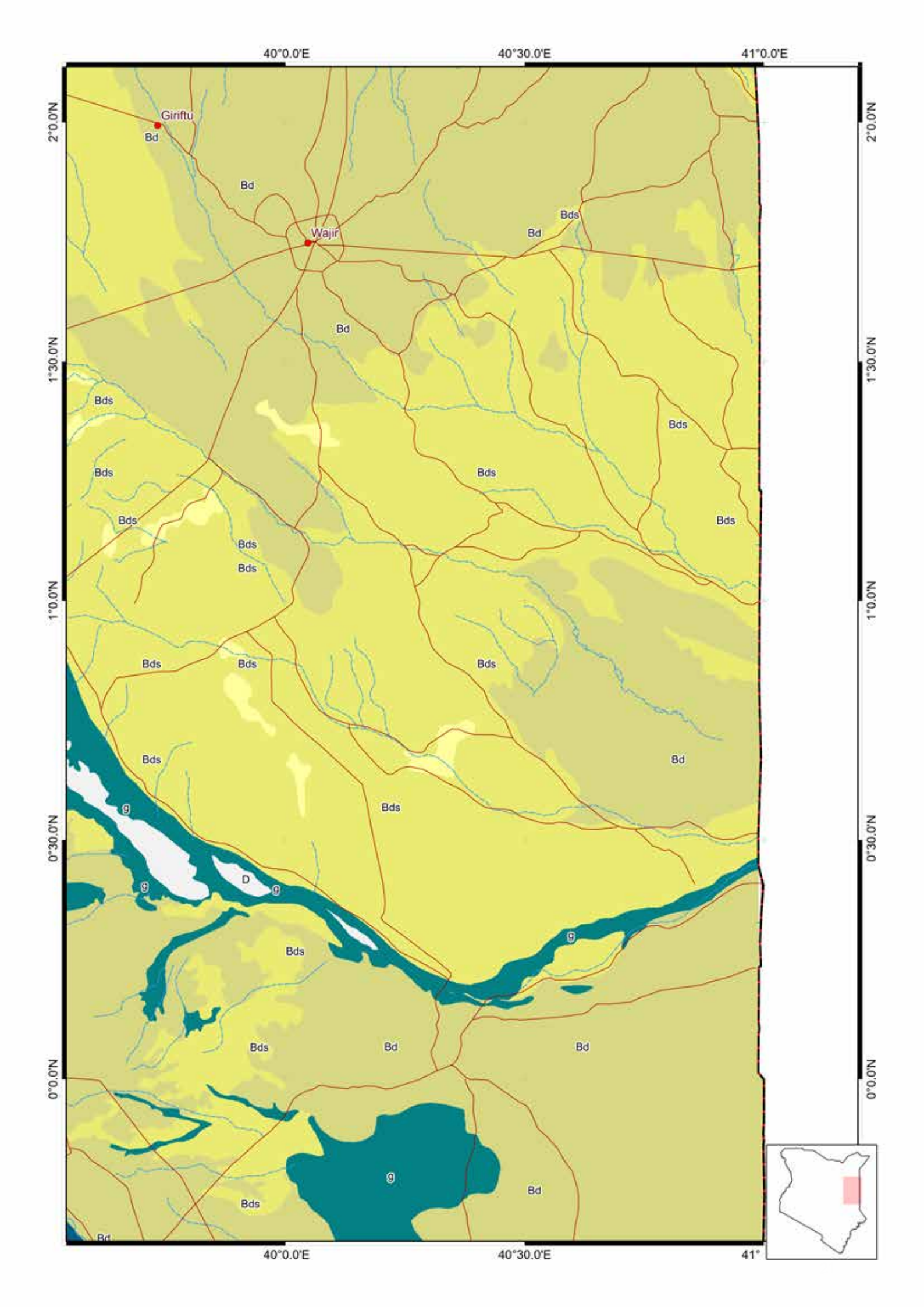
Giriftu
Bd
Bds
S
wd
g/X
Sericho
Merti
Habaswein
g
Mado Gashi
D
Garba Tula
Kora Wells
R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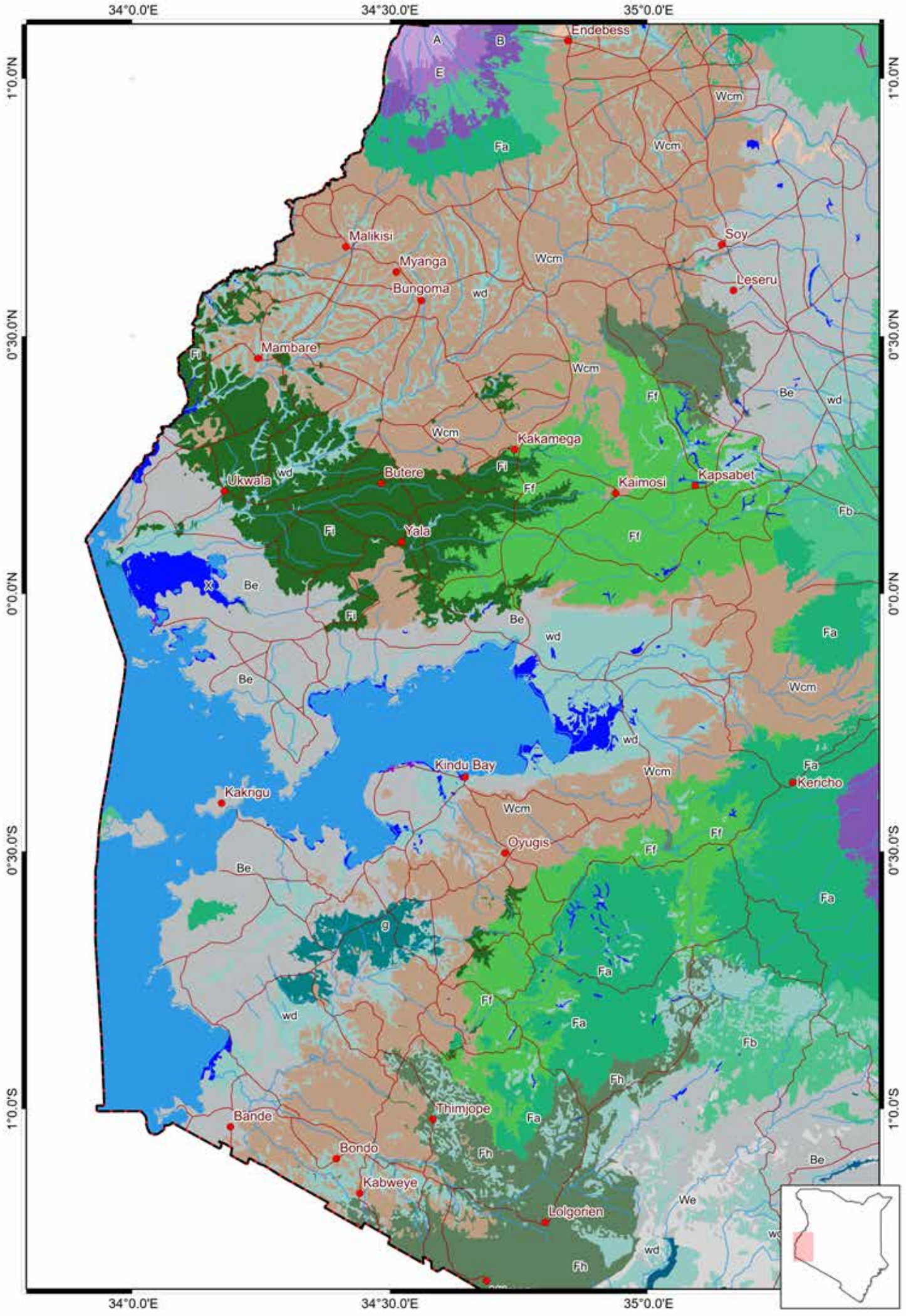
Giriftu
Wajir
Bd
Bds
g
D
41°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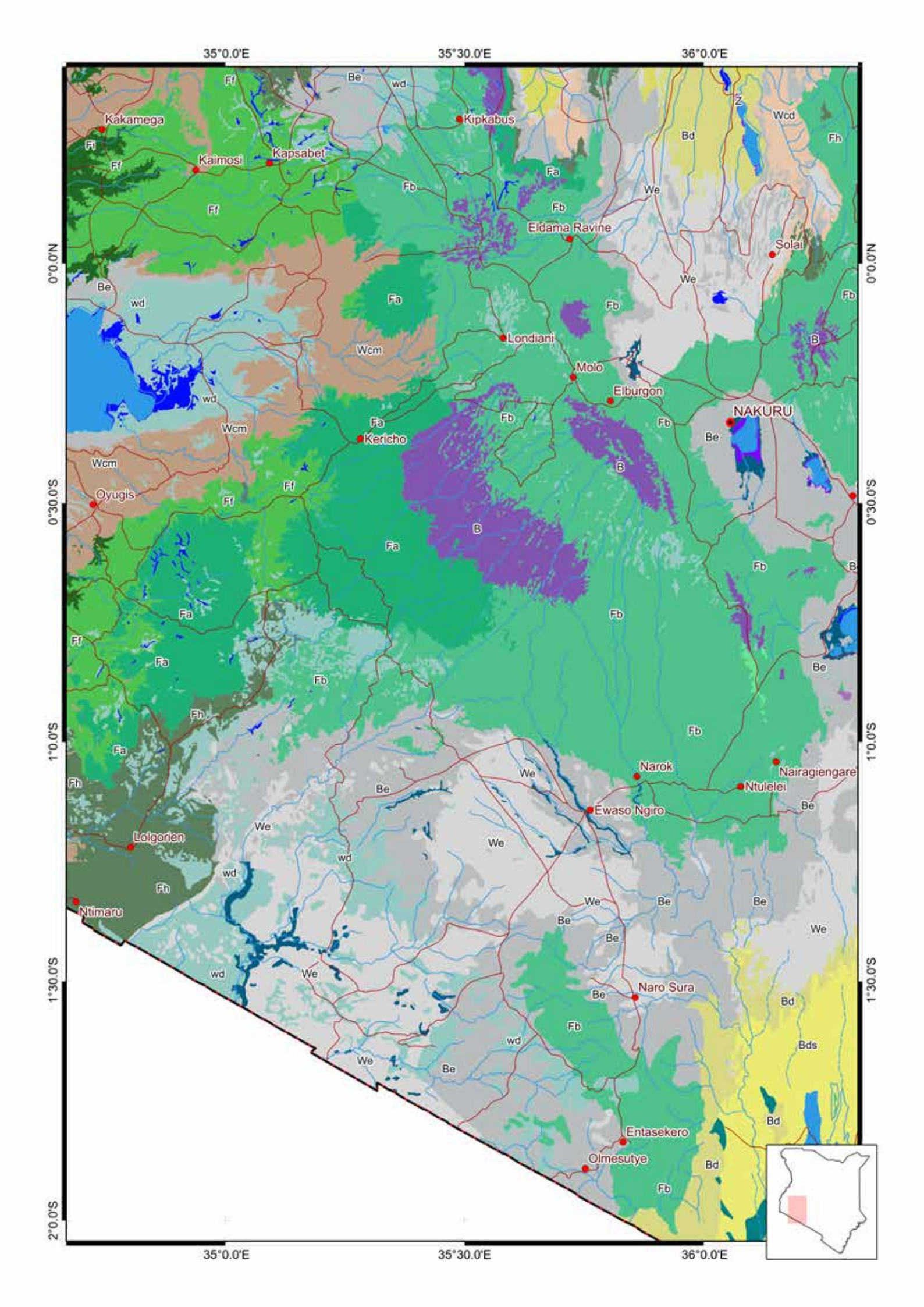
Endebess
Malikisi
Myanga
Bungoma
Mambare
Ukwala
Butere
Kakamega
Yala
Soy
Leseru
Kaimosi
Kapsabet
Kericho
Kindu Bay
Kakrngu
Oyugis
Thimjope
Bande
Bondo
Kabweye
Lolgorien
A
B
E
Fa
Wcm
wd
Fl
Ff
Be
Fb
Fh
X
g
We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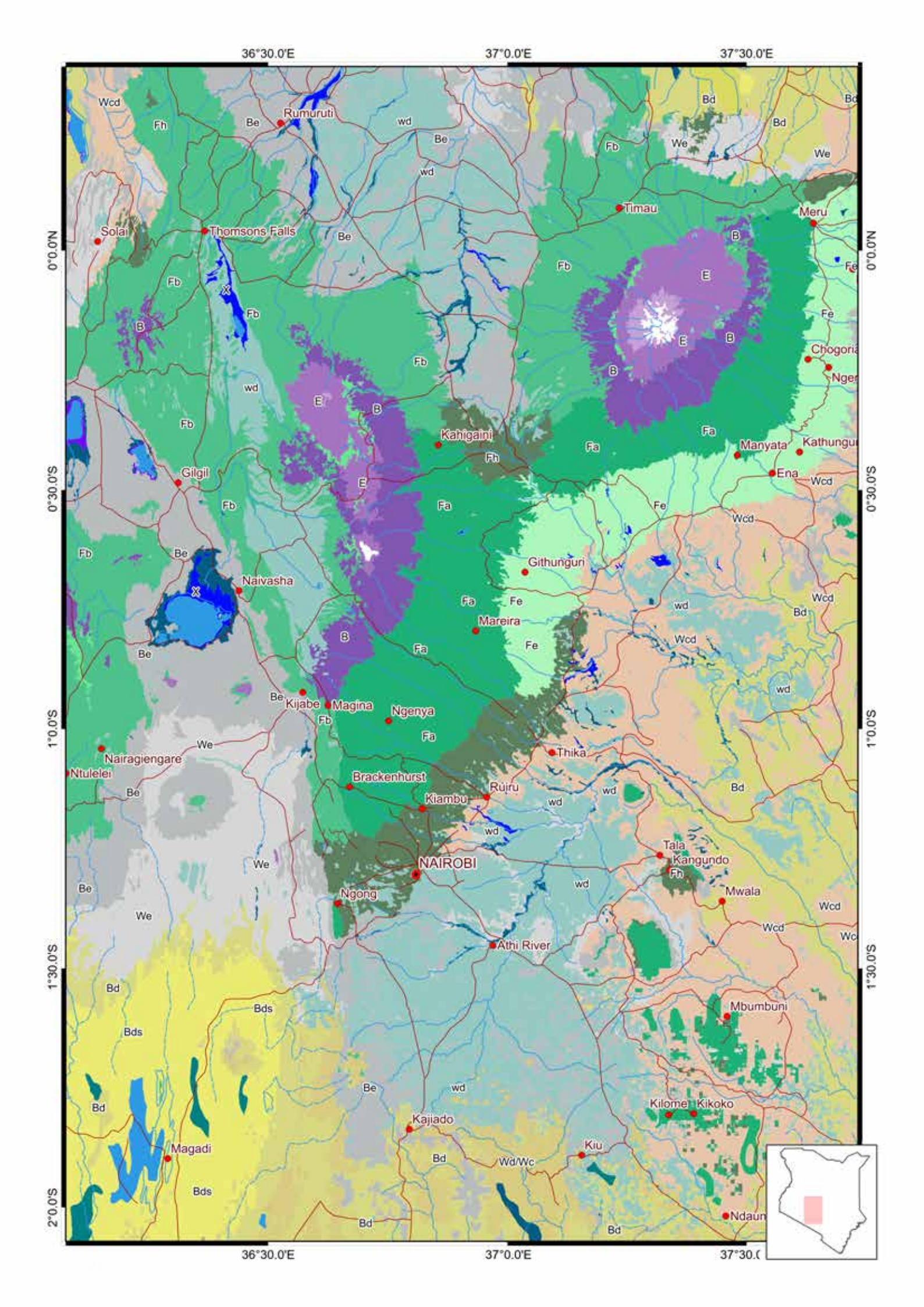
Kipkabus
Kaimosi
Kapsabet
Eldama Ravine
Solai
Londiani
Molo
Elburgon
NAKURU
Kericho
Oyugis
Narok
Nairagiengare
Ntulelei
Ewaso Ngiro
Lolgorien
Ntimaru
Naro Sura
Entasekero
Olmesutye
Ff
Fa
Fb
Fh
Be
wd
We
Wcm
Wcd
Bd
Bds
B
Z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0°30.0'S
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2°0.0'S
Rumuruti
Thomsons Falls
Solai
Timau
Meru
Chogoria
Kahigaini
Manyata
Kathungu
Ena
Gilgil
Naivasha
Githunguri
Mareira
Kijabe
Magina
Ngenya
Thika
Nairagiengare
Ntulelei
Brackenhurst
Kiambu
Ruiru
NAIROBI
Ngong
Tala
Kangundo
Mwala
Athi River
Mbumbuni
Kilome
Kikoko
Kajiado
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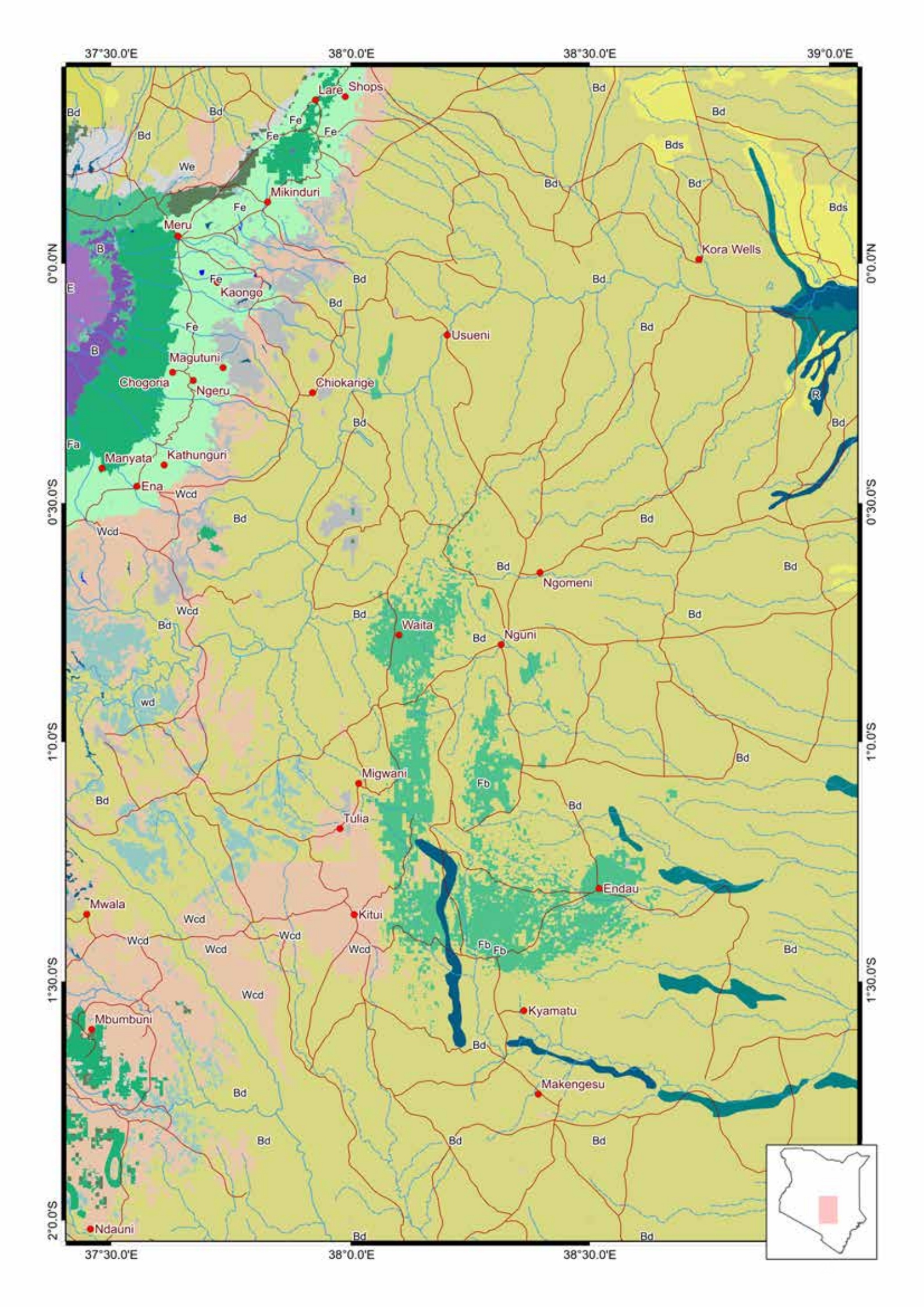
We
Bd
B
E
Fe
Fa
Bds
Wd/Wc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0°30.0'S
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1°30.0'S
2°0.0'S
Lare
Shops
Mikinduri
Meru
Kaongo
Magutuni
Chogoria
Ngeru
Chiokarige
Usueni
Kora Wells
Manyata
Kathunguri
Ena
Ngomeni
Waita
Nguni
Migwani
Tulia
Endau
Kitui
Mwala
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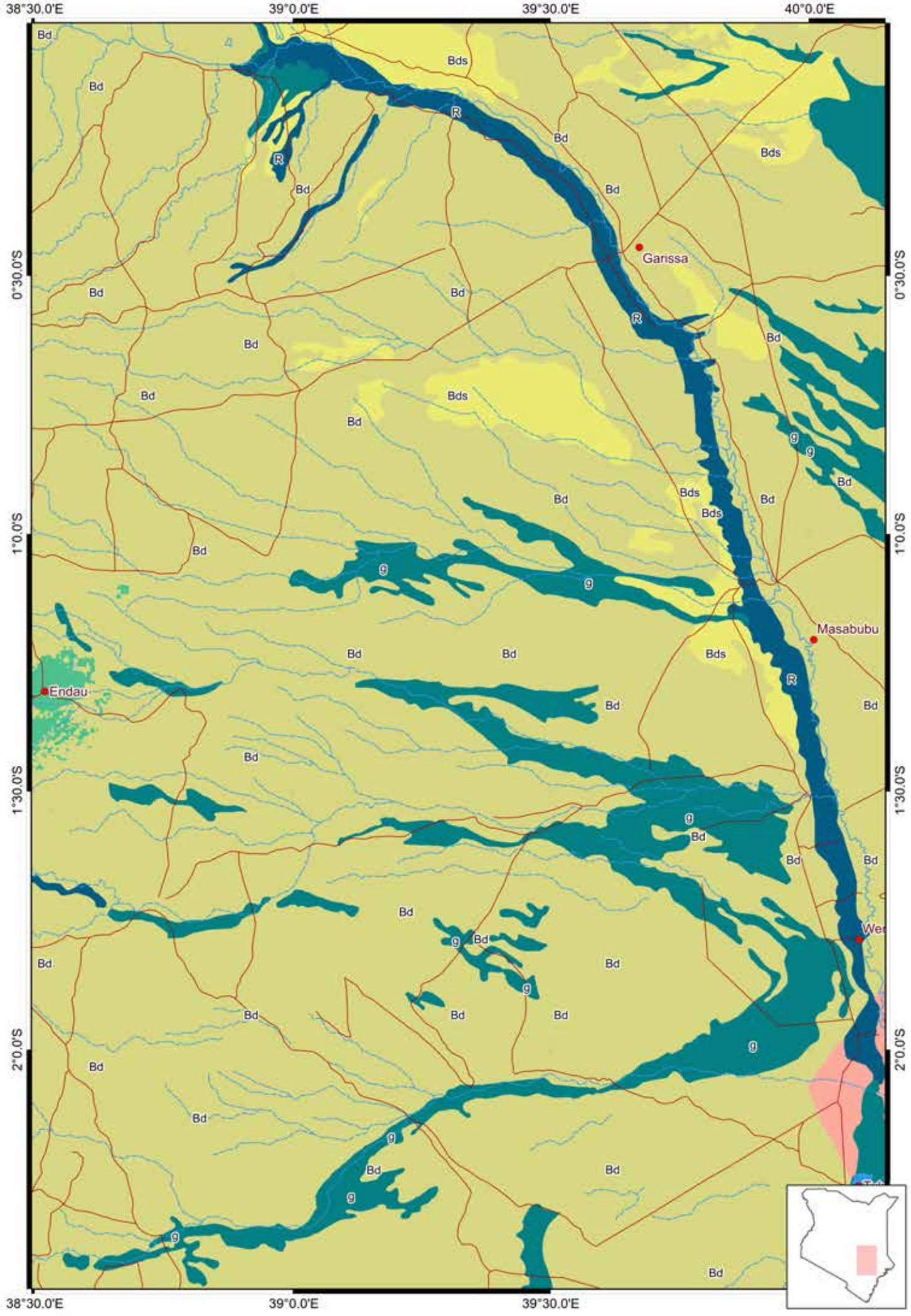
Ndauni
Bd
Bds
Fe
We
B
E
Fa
Fb
Wcd
wd
R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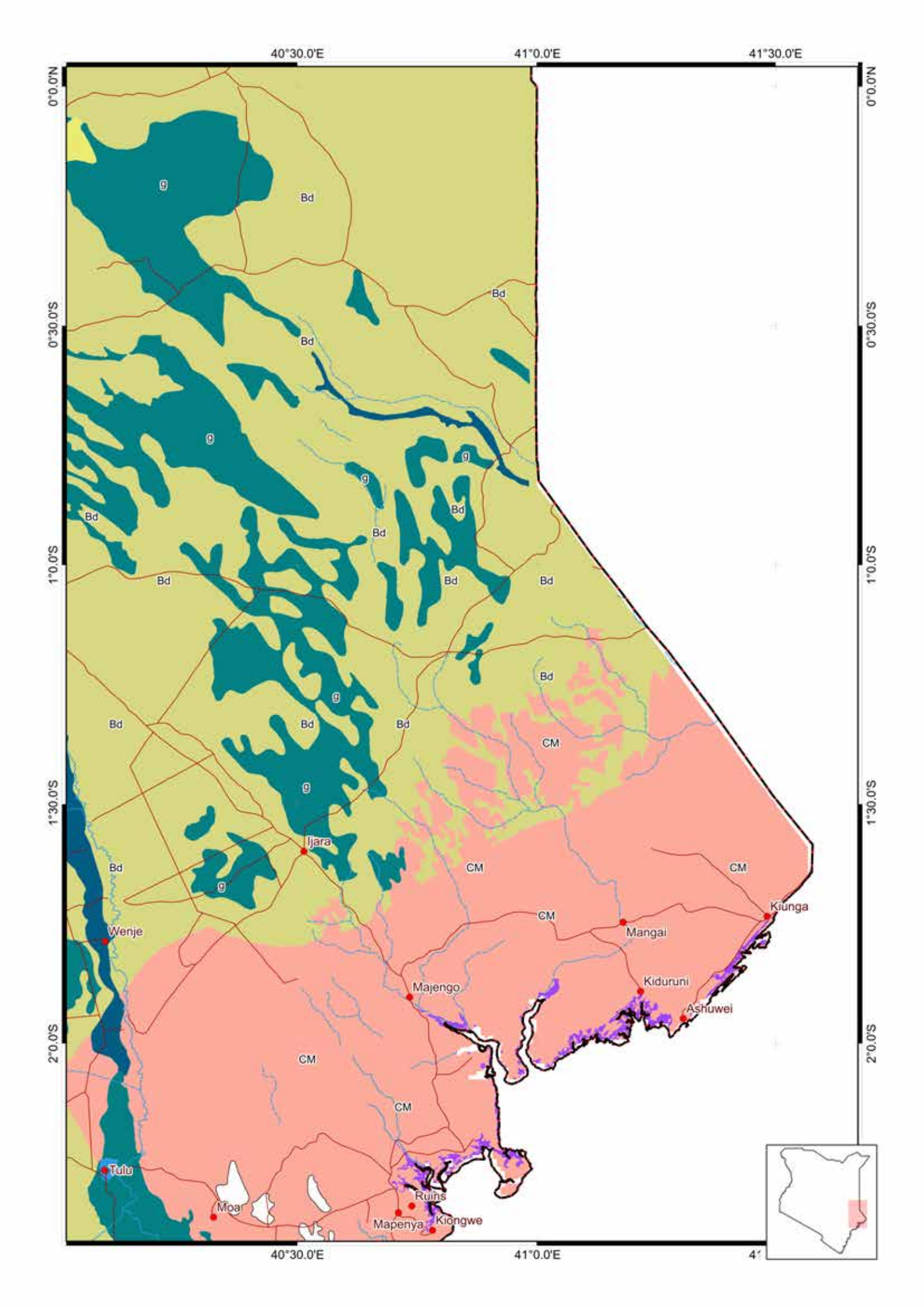
Garissa
Masabubu
Endau
Bd
Bds
R
g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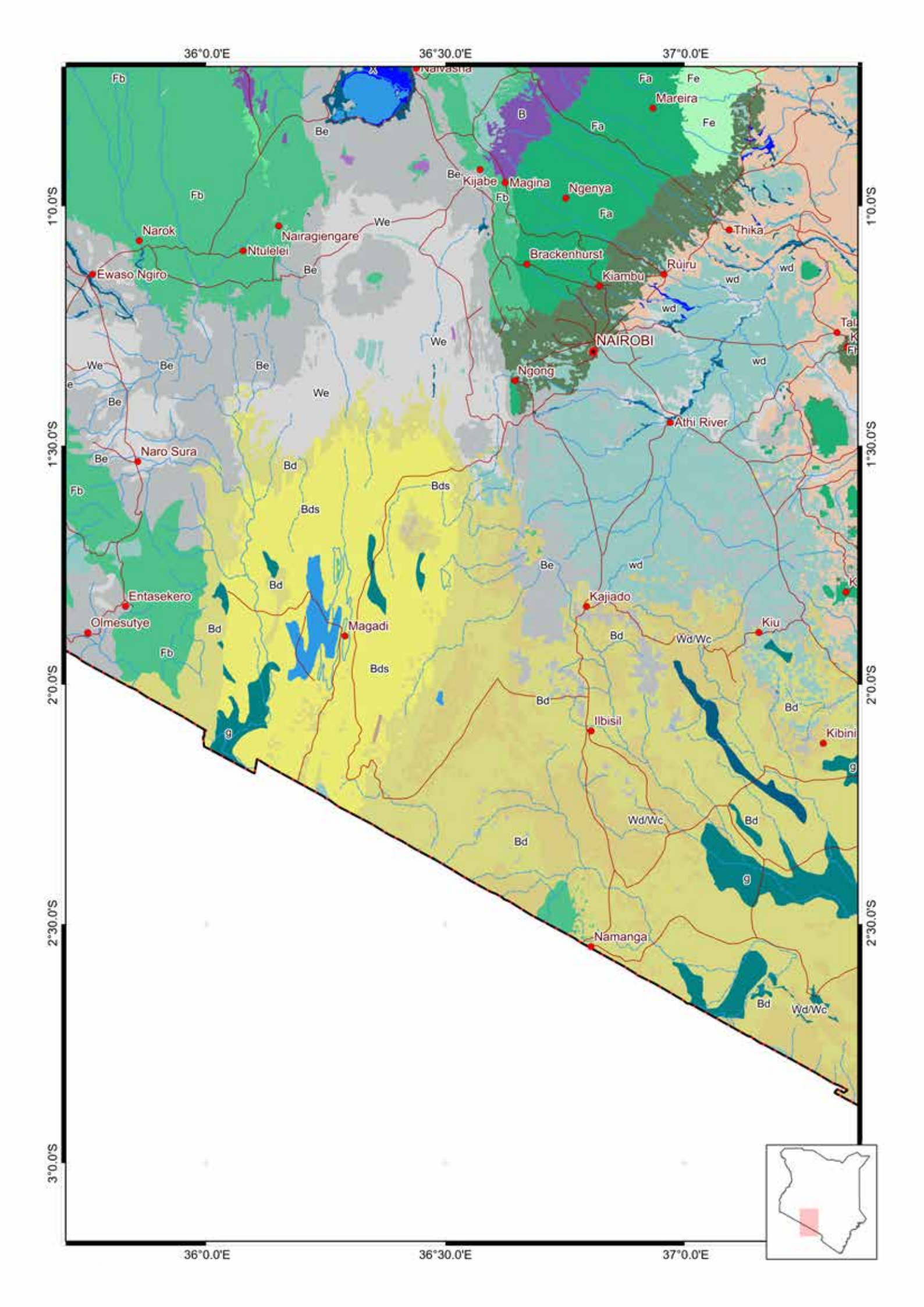
2°0.0'S
g
Bd
CM
Ijara
Wenje
Majengo
Mangai
Kiunga
Kiduruni
Ashuwei
Tulu
Moa
Ruins
Mapenya
Kiongwe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Naivasha
Mareira
Kijabe
Magina
Ngenya
Thika
Narok
Nairagiengare
Ntulelei
Ewaso Ngiro
Brackenhurst
Rùiru
Kiambu
NAIROBI
Ngong
Athi River
Naro Sura
Entasekero
Olmesutye
Magadi
Kajiado
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Fb
Fa
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Be
We
Bd
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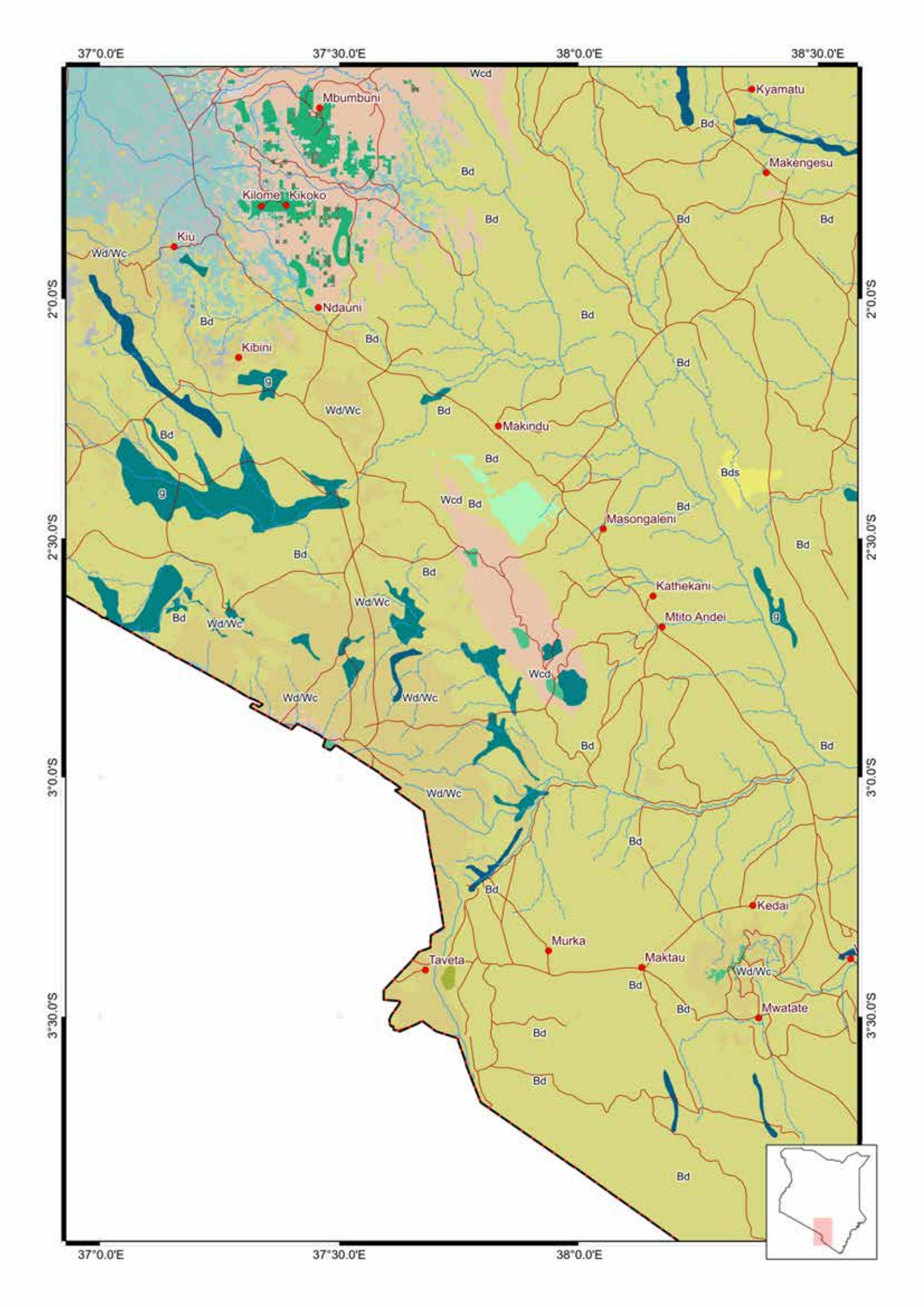
wd
Wd/Wc
g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Mbumbuni
Kyamatu
Makengesu
Kilome
Kikoko
Kiu
Ndauni
Kibini
Makindu
Masongaleni
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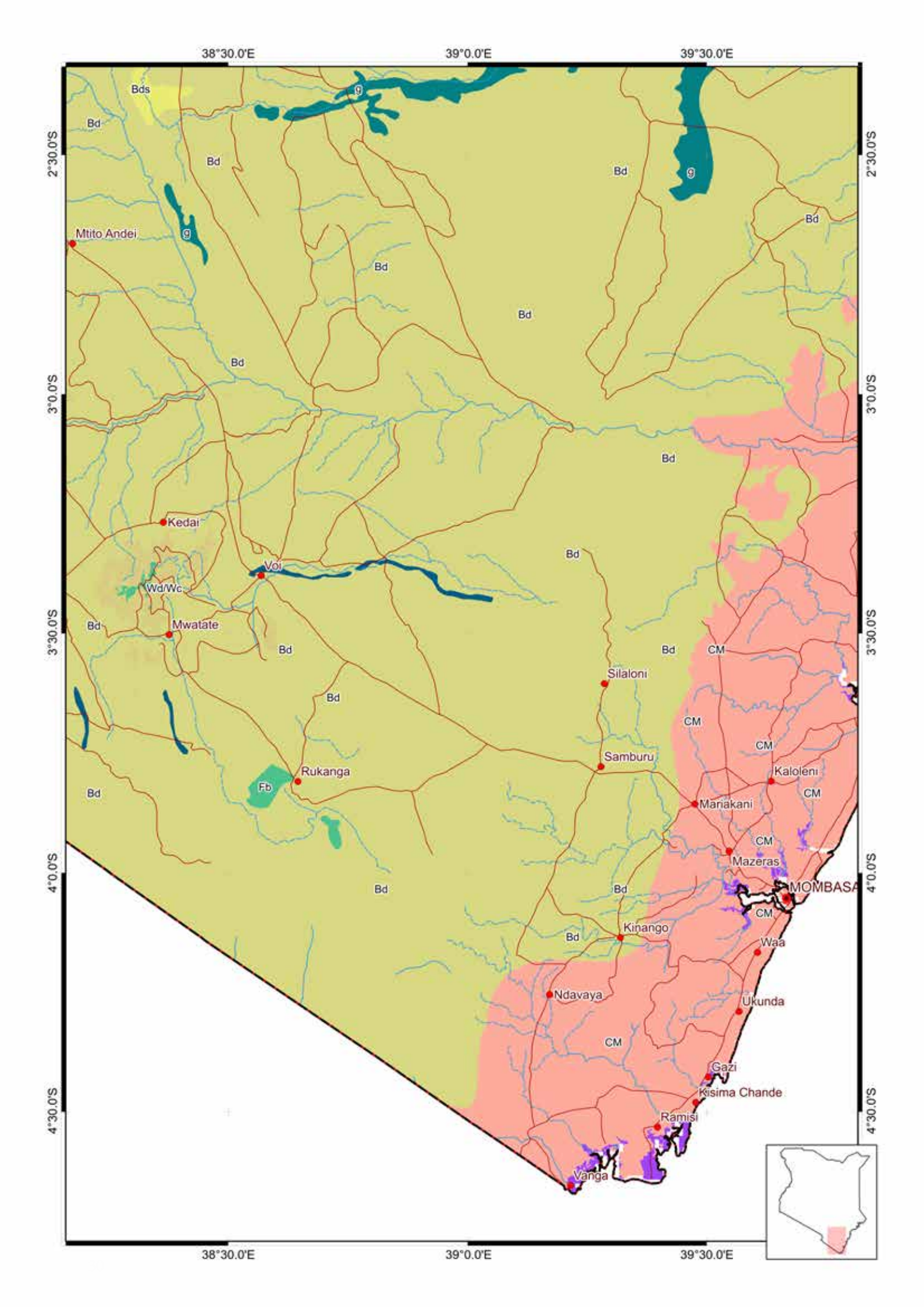
Wcd
Bd
Bds
Wd/Wc
g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4°30.0'S
Bds
Bd
Mtito Andei
Kedai
Voi
Wd/Wc
Mwatate
Rukanga
Fb
Silaloni
Samburu
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Waa
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Gazi
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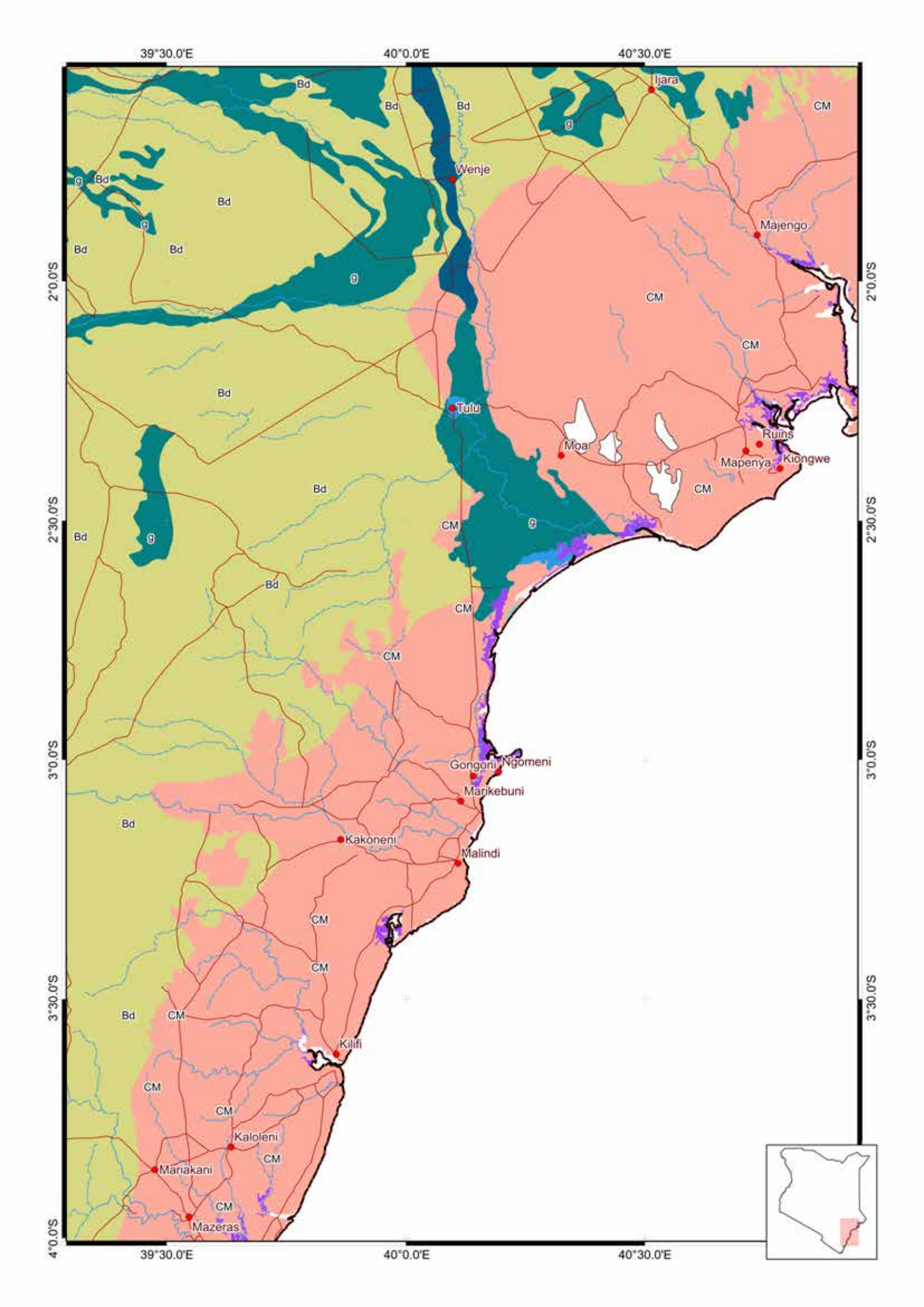
Ramisi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4°0.0'S
Ijara
Wenje
Majengo
Tulu
Moa
Ruins
Mapenya
Kiongwe
Gongoni
Ngomeni
Marikebuni
Kakoneni
Malindi
Kilifi
Kaloleni
Mariakani
Mazeras
Bd
CM
g

5. Description and species list for Kenya

5.1. Methodology

For each of the vegetation types, we obtained information on species assemblages (those tree species expected to occur in a particular vegetation type) based on information that was provided in the national references (details are provided in Volumes 2 to 5). For each of the countries where we had information on the national "manifestation" of a vegetation type (for example, Afromontane rain forest as it was described for Ethiopia by Friis et al. 2010), we created a separate column within which we gave an indication that a particular tree species was expected to occur within that vegetation type and within that country.

Where species were not listed in the national reference for a focal country, we checked with information on national lists of all the tree species that occur in the focal country whether the species could **potentially** occur in the focal vegetation type and focal country **because the species was documented to occur in the same vegetation type in other countries**. For example, the species *Cyathea dregei* was documented to occur in Afromontane rain forest in Malawi, Rwanda and Zambia. From the UNEP-WCMC species database, there was information that this species also occurs in Ethiopia. This led us to indicate that there was information that the species potentially occurred in Afromontane rain forest in Ethiopia (we used the coding of "f" in the species assemblage table to indicate this). **Note that it is possible that species indicated with "f" for a particular country and forest type do NOT occur in that particular country and forest type in reality (meaning that, in reality, differences exist between species assemblages of the same forest type between countries – or possibly indicating errors in the obtained species assemblage for a particular country).**

After compiling information on species assemblages, we selected a subset of species to feature in species composition tables. These were mainly "useful tree species", which are tree, bushland or liana species that were listed in at least one of the references that we consulted on tree species that are expected to be useful to farming or pastoral communities in the VECEA countries

Information that is provided in species composition tables was simplified from the information provided in Volumes 2 to 5, providing the following types of information:

- "x" in a species composition tables indicates that the species is expected to occur in the vegetation type based on references that we consulted or field experience from a national collaborator
- "C" in a species composition table indicates that the species is a characteristic species for the vegetation type (see Volumes 2 to 5 for details)

- "f" in a species composition table indicates that the species was not initially listed for the country, but could potentially occur because the species is known to occur in that particular country
- A "characteristic species" is a species that was listed for the focal vegetation type in a regional description of potential natural vegetation (this regional description was typically White 1983)
- A species that is "not characteristic" is a species that was not listed for the focal vegetation type in a regional description of potential natural vegetation
- An "indicator species" was defined as a characteristic species that was only listed once (i.e. for the focal vegetation type) among all the vegetation types of the same physiognomic classification and the same floristic region. For example, Chrysophyllum gorungosanum is an indicator species for Afromontane rain forest since this species was only listed for Afromontane rain forest (White 1983 p. 164) among all the forests described for the Afromontane floristic region.

Another modification from the species composition tables that were given in Volumes 2 to 5 is that we excluded species that were listed to be present (coding "x" or "C") in fewer than 50 percent of all the countries in which the vegetation type occurs. We implemented this change to increase consensus among national manifestations of the focal vegetation type (and especially to filter out marginal occurrence of a species), and also to increase confidence about the regional occurrence of a species. Although this approach has led to better agreements between national documentation, we may have excluded some species that widely occur in some situations (please compare the abbreviated lists provided here with the more comprehensive lists provided in Volumes 2 to 5 if you are particularly interested in these species).

6. Afromontane rain forest (Fa)

6.1. Description

Afromontane rain forest is very similar in structure (physiognomy) to certain types of Guineo-Congolian rain forest. Species composition, however, is almost entirely different (many tree genera have different species in Afromontane rain forest and Guineo-Congolian rain forest, on the other hand). Other physiognomic and floristic differentiation between Afromontane rain forest and Guineo-Congolian rain forest include the greater degree of bud protection, a lesser degree of drip tips of leaves development, the occurrence of tree ferns (*Cyathea*) and the occurrence of conifers (*Podocarpus*; especially *Podocarpus latifolius* as *Podocarpus falcatus* (synonym: *P. gracilior*) are more characteristic of Afromontane undifferentiated forest; White 1983 p. 164 - 165).

These forests occur mainly between 1200 and 2500 m on the slopes of certain mountains. However, the altitudinal limits vary greatly according to distance from the equator, proximity to the ocean, and size and configuration of the massif on which these forests occur (White 1983 p. 164). The observation that vegetation belts are scaled according to the size of the mountain on which they occur were first observed in the Alps, where this phenomenon is described as the 'Massenerhebung effect' (mass-elevation effect). The mean annual rainfall lies mostly between 1250 and 2500 mm. Mists that frequently occur during the dry season of one to five months may explain the fact that Afromontane rain forest is much less deciduous than lowland semi-evergreen forests that receive similar rainfall. Only a few of the larger tree species (*Entandophragma excelsum* and *Pouteria adolfi-friedericii*) lose their leaves - and then only for a few days (White 1983 p. 164).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Afromontane rain forest and no other Afromontane forest types) that were listed as characteristic species for one or several national maps include *Chrysophyllum gorungosanum*, *Cola greenwayi*, *Cylicomorpha parviflora*, *Entandrophragma excelsum*, *Ficalhoa laurifolia*, *Hallea rubrostipulata*, *Myrianthus holstii*, *Ochna holstii*, *Ocotea usambarensis*, *Olea capensis*, *Parinari excelsa*, *Pouteria adolfi-friedericii*, *Strombosia scheffleri*, *Syzygium guineense* ssp. *afromontanum* and *Tabernaemontana stapfiana*.

Figure 6.1. View of canopy from Afromontane rain forest (synonym: moist evergreen Afromontane forest) north of Masha (Ethiopia). Altitude approximately 1950 m. Photograph by I. Friis and Sebsebe Demissew (September 2002). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 25A. 2010.

Figure 6.2. Afromontane rain forest in Nyungwe National Park (Rwanda). Photograph by C. K. Ruffo (June 2008).

Figure 6.3. *Cyathea manniana* tree ferns in Lake Victoria transitional rain forest (Ff). The presence of tree ferns (*Cyathea* species) is typical for Afromontane rain forest (White 1983 p. 164). However, this species also occurs in other types of forests with admixture of Afromontane species. Photograph by F. Gachathi (2009).

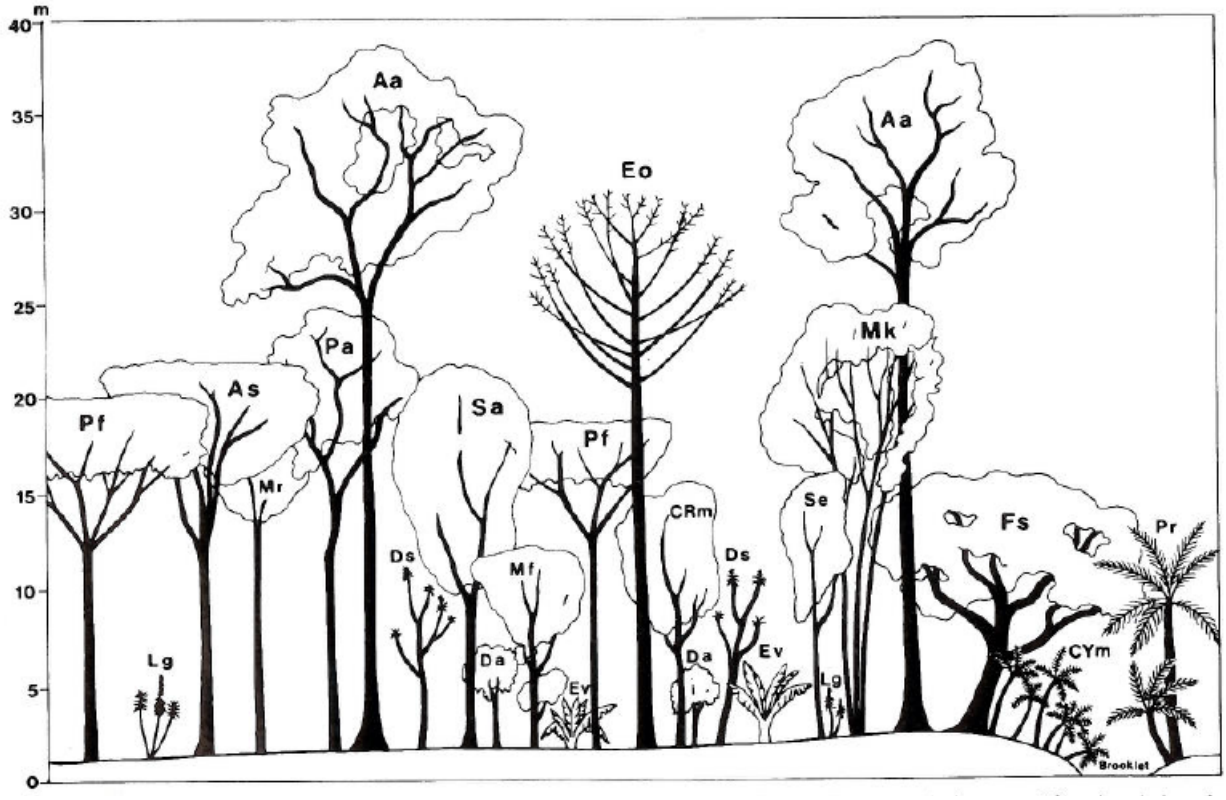

Figure 6.4. Transect of Primary or mature secondary moist evergreen Afromontane forest (classified in VECEA as Afromontane rain forest [Fa]). Generalised representation based on observations made in old secondary forest at approximately 1700 metres altitude south of Gore, IL floristic region. Although this locality is situated just below the altitudinal limit used for mapping (6) Moist evergreen Afromontane forest (Fa) no species restricted to (7) Transitional rain forest (mapped in VECEA as Afromontane moist transitional forest [Fe]) were observed, but a few species, for example *Hallea rubrostipulata*, are known from both vegetation types. The abbreviated names for the species stand for: Aa: *Pouteria (Aningeria) adolfi-friederici*. As: *Albizia schimperiana*. CRm: *Croton macrostachyus*. CYm: *Cyathea manniana*. Da: *Dracaena afromontana.* Ds: *Dracaena steudneri*. Eo: *Euphorbia ampliphylla*. Ev: *Enset ventricosum*. Fs: *Ficus sur*. Lg: *Lobelia giberroa*. Mf: *Millettia ferruginea.* Mk: *Macaranga capensis* var. *kilimandscharica*. Mr: *Hallea (Mitragyna) rubrostipulata*. Pa: *Prunus africana*. Pf: *Polyscias fulva*. Pr: *Phoenix reclinata*. Sa: *Schefflera abyssinica*. Sa: *Sapium ellipticum*. Drawn by Victoria C. Friis. Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 24. 2010.

6.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country)

Table 6. Species composition of Afromontane rain forest (Fa)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania (FarT subtype)	Tanzania (FawT subtype)	Uganda	Zambia
Chrysophyllum gorungosanum	indicator species		C	C	x	x	f	C	f
Cola greenwayi	indicator species		C	C		x	f		C
Cylicomorpha parviflora	indicator species		C	x		f	f		
Entandrophragma excelsum	indicator species			C	C	f	f	C	f
Ficalhoa laurifolia	indicator species			C	C	x	C	f	f
Hallea rubrostipulata	indicator species	C	x	x		x	f	f	
Myrianthus holstii	indicator species		x	x	x	x	f	f	f
Ochna holstii	indicator species	x	C	x	x	x	C	f	f
Ocotea usambarensis	indicator species		C	C	C	x	C	f	f
Olea capensis	indicator species	C	C	C	C	f	C	C	f
Parinari excelsa	indicator species			C	C	x	f	f	C
Pouteria adolfi-friedericii	indicator species	C	C	C	x	C	C	C	C
Strombosia scheffleri	indicator species		C	C	C	x	f	C	
Syzygium guineense	indicator species (*Syzygium guineense* ssp. *afromontanum*)	C	C	x	C	x	f	x	f
Tabernaemontana stapfiana	indicator species		C	x	x	f	f	x	
Diospyros abyssinica	characteristic species	x	C	x	f	f	f	f	f
Podocarpus latifolius	characteristic species (conifer species that is absent from Guineo-Congolian rain forest, but more characteristic of other types of Afromontane forest)		C	C	C	f	C	C	C
Prunus africana	characteristic species	C	C	C	C	f	x	C	f
Xymalos monospora	characteristic species		C	x	C	x	C	x	f
Acacia abyssinica	invasive species	x	C	x	f	f	f	f	
Acacia lahai	invasive species	f	x			f	f	f	
Agauria salicifolia		f	x	x	x	f	x	f	C
Albizia grandibracteata		C	x		f	f	f	f	
Albizia gummifera	not characteristic	C	C	C	f	x	f	C	f
Albizia schimperiana		C	f	C		f	f	f	f
Alchornea hirtella			x	x	x	f	f	f	f
Allophylus abyssinicus		x	C	x	x	f	f	x	f
Allophylus africanus		f	C	f	f	f	f	f	f
Anthocleista grandiflora			C	x		x	f	x	
Apodytes dimidiata	not characteristic	x	C	C	x	f	f	f	f
Balthasaria schliebenii							C		
Berberis holstii		f	x	x		f	f	f	
Bersama abyssinica		x	C	x	x	x	x	C	f
Blighia unijugata		x	x	f	f	f	f	f	f
Bridelia brideliifolia				x	C	f	C	f	
Carapa procera					C	f	f	f	
Casearia battiscombei			C	x		f	f	f	
Cassipourea malosana	not characteristic	C	C	C		f	C	x	f
Cassipourea ruwensoriensis		f	f		C	f	f	f	
Catha edulis		f	C	x	f	f	f	f	f
Celtis africana		C	C	C	f	f	f	f	f
Celtis gomphophylla		f	x	x	f	f	f	f	f
Clausena anisata		x	x	x	x	f	f	x	f
Cordia africana		x	x	f	f	f	f	f	f
Cornus volkensii			C	C	x	x	f	f	
Croton macrostachyus		C	C	C	x	f	f	x	f
Croton megalocarpus	not characteristic		f	x	x	f	f	f	f
Croton sylvaticus		f	C	x		f	f	f	f
Cussonia spicata			x	C		f	f	x	f
Cyathea dregei	tree fern that is characteristic of Afromontane rain forest and that is absent from Guineo-Congolian rain forest	f	f	x	x	f	f		f
Cyathea humilis	tree fern that is characteristic of Afromontane rain forest and that is absent from Guineo-Congolian rain forest		x			f	f		
Cyathea manniana	tree fern that is characteristic of Afromontane rain forest and that is absent from Guineo-Congolian rain forest	x	x	x	x	f	f	C	
Discopodium penninervium		f	x	x	x	f	f	f	
Dodonaea viscosa		f	f	x	x	f	f	f	f
Dombeya torrida		x	C	x	x	f	C	x	
Dovyalis abyssinica		f	x	x		f	f	f	f
Dovyalis macrocalyx			x	x	x	f	f	f	f
Dracaena fragrans		x	f	x	f	f	f	f	
Dracaena steudneri		x	C	x	x	f	f	x	f
Ehretia cymosa		x	C	x	x			f	
Ekebergia capensis		C	C	C	x	f	f	x	f
Elaeodendron buchananii		x	f	x	f	f	f	f	f
Embelia schimperi		f	x	x	x	f	f	f	f
Ensete ventricosum		x	f	x	x	f	f	f	f
Eugenia capensis		x	f	x	x	f	f	f	f
Euphorbia abyssinica		f	C	x		f	f	x	f
Fagaropsis angolensis	not characteristic	x	f	x	x	f	f	f	f
Ficus exasperata		f	x	f	x	f	f	f	f
Ficus natalensis			x	x	x	f	f	f	f
Ficus ovata		C	f	x	f	f	f	f	f
Ficus sur		C	C	x	f	f	f	f	f

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania (FarT subtype)	Tanzania (FawT subtype)	Uganda	Zambia
Ficus thonningii		C	C	C	f	f	f	f	f
Galiniera saxifraga		x	C	x	C	f	f	C	
Garcinia buchananii		x	x	f	f	f	f	x	f
Hagenia abyssinica		f	C	C	C	f	f	f	f
Harungana madagascariensis			C	f	f	f	f	f	f
Hypericum revolutum		f	f	x	x	f	f	f	f
Ilex mitis	not characteristic	C	x	C	x	f	C	x	f
Kigelia moosa			C			f	f	f	
Landolphia buchananii		x	f	x		f	f	f	f
Lepidotrichilia volkensii		x	C	x	x	f	f	C	f
Macaranga capensis		f	C	C	C	x	C	C	f
Maesa lanceolata		x	C	f	x	f	C	x	C
Manilkara butugii		x	x					f	
Maytenus acuminata			C	C	x	f	C	x	f
Maytenus undata		x	x	x	x	f	f	f	f
Milicia excelsa		f	x	x	f	f	f	f	
Millettia dura			x	x	f	f	f	f	
Neoboutonia macrocalyx			C	C	C	x	f	x	f
Newtonia buchananii	not characteristic		x	f	x	x	f	f	f
Nuxia congesta	not characteristic	x	C	x	x	f	C	f	f
Nuxia floribunda	not characteristic		f	x	x	f	f	f	f
Ocotea kenyensis	not characteristic	C	C	x	x	f	x	f	
Olea europaea	not characteristic	f	C	x	f	f	f	f	f
Olinia rochetiana		f	f	x	x	f	x	f	f
Peddiea fischeri			x		x	f	f	f	f
Phoenix reclinata	palm species	x	x	x	f	f	f	f	f
Phytolacca dodecandra		f	x	x	f	f	f	f	f
Pittosporum viridiflorum		x	x	x	x	f	x	C	f
Pleiocarpa pycnantha			x		x	f	f	f	f
Podocarpus falcatus	not characteristic	x	x	x	C	C	f	f	
Podocarpus henkelii	conifer species that is absent from Guineo-Congolian rain forest, but more characteristic of other types of Afromontane forest; species that is very localized north of the Limpopo river			C					
Podocarpus usambarensis	conifer species that is absent from Guineo-Congolian rain forest, but more characteristic of other types of Afromontane forest		x			f	f	f	
Polyscias fulva		C	f	C	C	x	f	x	f
Pouteria altissima		f	f		f	f	f	f	C
Psychotria mahonii			C	x	x	f	x	C	f
Psydrax parviflora		f	C	x	x	f	f	f	f
Pterolobium stellatum		f	x	x	f	f	f	f	f
Rapanea melanophloeos	not characteristic	f	C	C	x	f	C	x	f
Rauvolfia caffra			f	x		x	f	f	f
Rhamnus prinoides		x	x	x	x	f	f	x	f
Rinorea angustifolia			x		x	f	f	f	
Ritchiea albersii		x	x		x	f	f	f	f
Rothmannia urcelliformis		x	f	x		f	f	f	f
Rubus apetalus		f	x	x	x	f	f	f	f
Sambucus ebulus			x			f	f	f	
Schefflera abyssinica		C	C	C		f	f	x	f
Schefflera volkensii		x	C			f	f	C	
Scutia myrtina		f	x	x	f	f	f	f	f
Shirakiopsis elliptica		C	x	x	x	f	f	f	f
Sinarundinaria alpina	Afromontane bamboo	C	f	x	x	f	f	x	
Smilax anceps		x	x		x	f	f	f	f
Solanecio mannii		x	f	x	f	f	f	f	f
Solanum aculeastrum			x	x	x	f	f	f	
Symphonia globulifera					C	f	C	C	f
Synsepalum brevipes			C	f		f	f	f	f
Syzygium cordatum							C		f
Tabernaemontana pachysiphon			C	f		f	f	f	f
Trema orientalis		x	x	f	x	f	f	f	f
Trichilia dregeana		x	x	f		f	f	f	f
Vangueria apiculata		f	f	x	x	f	f	f	f
Vepris nobilis		x	C	x	x	f	f	f	f
Vernonia auriculifera		x	x		x	f	f	f	
Vernonia myriantha		x	x	x	x	f	f	f	f
Vitex keniensis			C						
Zanthoxylum gilletii		f	C		x	f	f	f	

7. Afromontane undifferentiated forest (Fbu) and Afromontan single-dominant *Juniperus procera* forest (Fbj)

7.1. Description

Afromontane undifferentiated forest is usually shorter than Afromontane rain forest (Fa). Although there is some floristic overlap in species composition between these two forest types (for example, *Podocarpus latifolius*, *Prunus africana* and *Xymalos monospora* were listed as characteristic species both for Afromontane rain forest and Afromontane undifferentiated forest), species composition is distinctive (White 1983 p. 165). White (1983) reserved the term of "undifferentiated forests" to forests that undergo rapid and kaleidoscopic changes in structure and species composition over short distances (White 1983 p. 47).

Afromontane undifferentiated forest usually replaces Afromontane rain forest at comparable altitudes (usually between 1250 and 2500 m) on the drier slopes of mountains and at higher altitudes on the wetter slopes, and sometimes at lower altitudes. Afromontane undifferentiated forest usually receives lower rainfall (possibly as low as 850 mm, which is the upper rainfall limit of East African evergreen bushland [Be]) than Afromontane rain forest (White 1983 p. 165).

After fire, Afromontane undifferentiated forests are sometimes replaced by almost pure stands of Afromontane single-dominant *Juniperus procera* forest (Fbj), Afromontane single-dominant *Widdringtonia whytei* forest (Fc) or Afromontane single-dominant *Hagenia abyssinica* forest (Fd). Within the VECEA map, we mapped the latter two types of forests (Fc and Fd) separately but mapped Afromontane undifferentiated forest together with Afromontane single-dominant *Juniperus procera* forest (Fbj). We made this decision especially since most of the national maps only listed one of these two forests types, whereas our floristic and environmental analysis suggested that both these forests belonged to the same potential natural vegetation type.

Afromontane single-dominant *Juniperus procera* forest (Fbj) mostly occurs on the drier slopes of mountains between 1800 and 2900 m, although it sometimes descends to 1000 m. Annual rainfall is usually between 1000 and 1150 mm, but sometimes more than 1250 mm. *Juniperus procera* also occurs outside forests as in evergreen bushland (Be, see volume 5) where rainfall can be as low as 650 mm - this could be the original habitat of this species (for example, the species occurs in evergreen bushland [Be] at lower elevations on Mt. Kulal [Kenya] where it is 4 to 6 m tall [White 1983 p. 121]). *Juniperus procera* is a strong light-demander that does not regenerate in its own shade, so its presence as forest tree depends on fire. This species also seems to be intolerant of deep humus layers (White 1983 p. 165 - 166). Besides the potentially dominant *Juniperus procera*, regional indicator spe

cies (characteristic species listed by White (1983) [1983] that were only provided for Afromontane undifferentiated forest and no other Afromontane forest types) that were listed as characteristic species for one or several national maps include *Halleria lucida*, *Ilex mitis*, *Kiggelaria africana* (this species does not extend as far north as Ethiopia), *Nuxia congesta*, *Nuxia floribunda* (this species does not extend as far north as Ethiopia), *Ocotea kenyensis*, *Podocarpus falcatus* (synonym: *Podocarpus gracilior*)

Figure 7.1. Afromontane undifferentiated forest with canopy of *Juniperus procera* and *Podocarpus falcatus i*n Chilimo forest (Ethiopia). Altitude approximately 2550 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 20A. 2010.

Figure 7.2. Afromontane single-dominant *Juniperus procera* forest with a tree of *Hagenia abyssinica* in the foreground near the upper edge of Chilimo forest (Ethiopia). Altitude approximately 3000 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 21B. 2010.

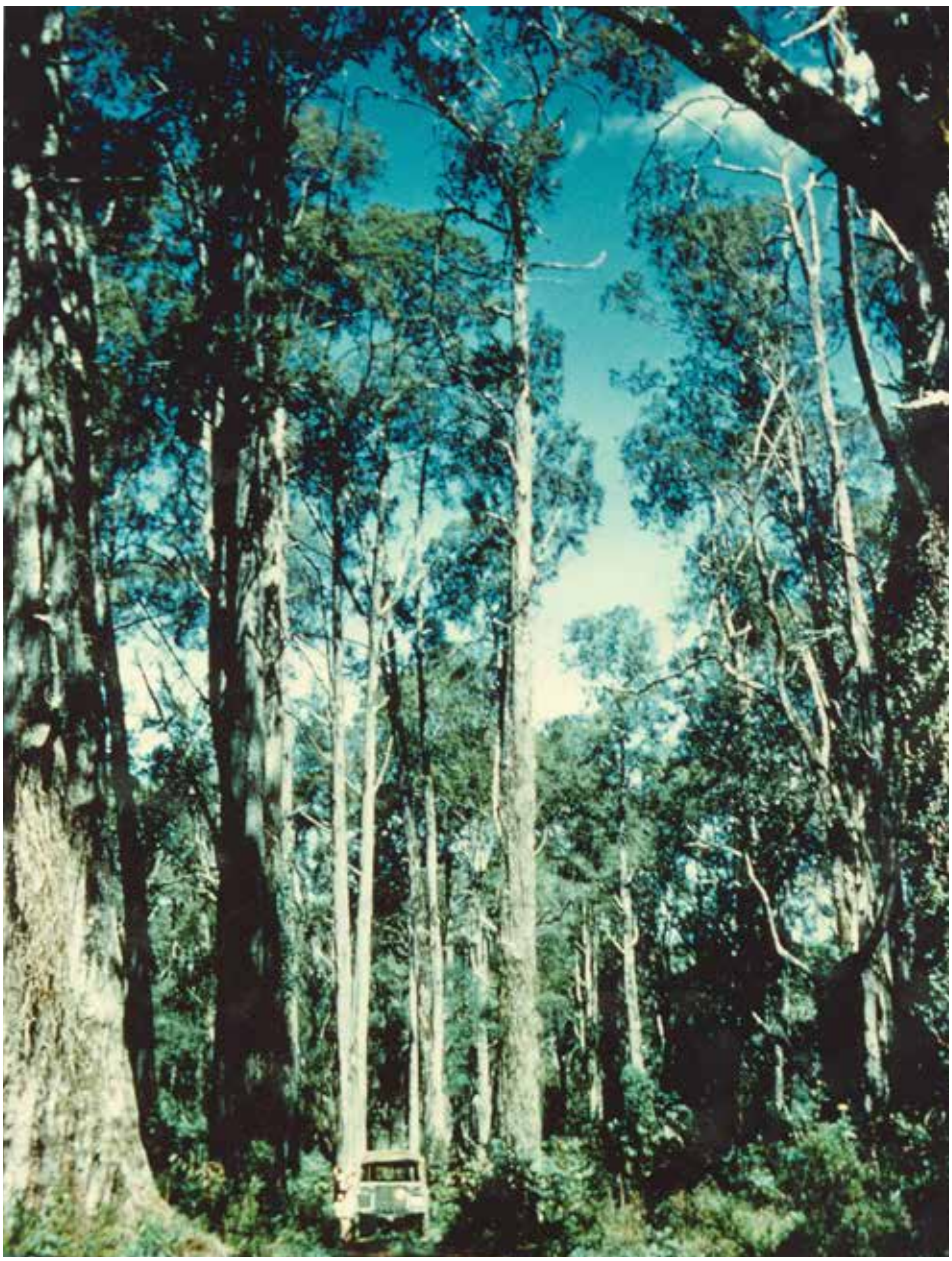

Figure 7.3. Climax stand of *Juniperus procera* (30 - 37 m) in Afromontane single-dominant *Juniperus procera* forest. Photographed in 1960 by unknown photographer at unknown location (presumably in Kenya). Photograph given to F. Gachachi by C.G. Trapnell (before his decease).

Figure 7.4. Afromontane single-dominant *Juniperus procera* forest in Maralal District (Kenya, leflt image, photograph taken in 2009) and Mt. Kenya (right image, photograph taken in 2011). Photographs by F. Gachathi.

Figure 7.5. A glade in Afromontane undifferentiated forest (synonym: montane sclerophyll forest) with *Juniperus procera* on the right and an unidentified *Podocarpus* species on the left. Afromontane bamboo (*Sinarundinaria alpina*, synonym: *Arundinaria alpina*) is portrayed behind the unidentified *Podocarpus* species. Western slopes of Mt. Kenya along the Sirimon track. Shell guide to East African birds (reproduced with permission from URL *http://ufdc.ufl.edu/UF00077050*).

7.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country)

Table 7. Species composition of Afromontane undifferentiated forest (Fbu) and Afromontane single-dominant *Juniperus procera* forest (Fbj)

SPECIES	Regional status	Ethiopia (FbuE subtype)	Ethiopia (FbjE subtype)	Kenya	Malawi	Tanzania	Uganda	Zambia
Juniperus procera	dominant in single-dominant Juniperus procera forest	C	D	C	D	C	C	
Halleria lucida	indicator species	x	x	x	x	C	f	f
Ilex mitis	indicator species	x	f	C	C	x	C	f
Kiggelaria africana	indicator species (species does not extend as far north as Ethiopia)				x	f		
Nuxia congesta	indicator species	x	C	C	C	C	x	C
Nuxia floribunda	indicator species (species does not extend as far north as Ethiopia)			f	x	x	x	C
Ocotea kenyensis	indicator species	f	f	f	f	f	f	
Podocarpus falcatus	indicator species (conifer species that is absent from Guineo-Congolian rain forest and less characteristic of Afromontane rain forest)	C	f	C	f	f	C	
Rapanea melanophloeos	indicator species	x	C	C	C	C	x	C
Apodytes dimidiata	characteristic species	C	f	C	x	C	f	f
Podocarpus latifolius	characteristic species (conifer species that is absent from Guineo-Congolian rain forest and less characteristic of Afromontane rain forest; species does not extend as far north as Ethiopia)			C	C	f	x	f
Prunus africana	characteristic species	C	f	C	C	C	x	f
Xymalos monospora	characteristic species (species that does not extend as far north as Ethiopia)			x	C	f	f	f
Acacia abyssinica	invasive species	f	f	C	f	f	x	
Acacia lahai	invasive species	f	f	C		f	f	
Acokanthera schimperi		f	C	f		f	f	
Agauria salicifolia		x	f	x	x	C	f	f
Albizia gummifera	not characteristic	x	f	C	f	C	x	f
Allophylus abyssinicus		C	f	x	f	f	x	f
Berberis holstii		f	f	x	x	f	C	
Bersama abyssinica		C	x	C	x	C	x	f
Blighia unijugata		f	f	x	f	f	x	f
Buddleja polystachya		f	C	x		f	f	
Carissa spinarum		x	C	f	f	f	f	f
Cassipourea malosana	not characteristic	C	f	C	C	C	x	f
Catha edulis		f	f	f	f	C	C	f
Celtis africana		C	f	C	x	f	x	f
Clausena anisata		x	C	x	x	f	x	f
Clerodendrum myricoides		x	C	f		f	f	
Cordia africana		x	f	f	f	f	x	f
Cornus volkensii				C	f	f	f	
Croton macrostachyus		C	f	C	f	C	x	f
Croton megalocarpus	not characteristic			f	f	x	x	f
Cussonia holstii		x	f	C		x	x	
Cussonia spicata				C	C	C	x	f
Diospyros abyssinica	not characteristic	x	f	C	f	x	x	f
Discopodium penninervium		x	C	f	f	f	x	
Dodonaea viscosa		x	C	C	f	f	x	f
Dombeya torrida		x	f	C	x	x	x	
Dovyalis abyssinica		C	x	C	f	f	x	f
Dovyalis macrocalyx				x	x	f	x	f
Dracaena steudneri		C	f	C	f	f	x	f
Ehretia cymosa		x	C	C	f		f	
Ekebergia capensis		C	x	C	x	C	C	f
Erica arborea		x	C	f		f	x	
Erythrina abyssinica		f	f	f	f	C	x	f
Erythrina brucei		C	f					
Euclea divinorum	not characteristic	x	x	C	x	C	C	f
Euclea racemosa		f	C	f	f	f	x	f
Euphorbia abyssinica		f	C	C	f	f	f	f
Euphorbia tirucalli		f	C	f	f	f	f	f
Fagaropsis angolensis	not characteristic	x	f	f	f	x	x	f
Faurea saligna				C	f	x	x	f
Ficus ovata		C	f	f	f	f	f	f
Ficus sur		C	f	C	f	f	x	f
Ficus thonningii		C	f	C	x	f	x	f
Galiniera saxifraga		x	C	C	f	f	f	
Grewia ferruginea		x	C					
Hagenia abyssinica		x	x	C	x	C	f	f
Hypericum revolutum		x	f	C	f	f	x	f
Hypericum roeperanum		x	x	f		f	x	f

SPECIES	Regional status	Ethiopia (FbuE subtype)	Ethiopia (FbjE subtype)	Kenya	Malawi	Tanzania	Uganda	Zambia
Lannea fulva				f		f	x	
Lepidotrichilia volkensii		C	f	C	x	f	f	f
Maesa lanceolata		x	C	f	x	x	x	f
Margaritaria discoidea		x	f	f	f	C	x	f
Maytenus acuminata				f	x	x	f	f
Maytenus undata		C	x	C	f	f	C	f
Mimusops kummel		x	f	f	f	f	x	
Morella salicifolia		x	f					
Myrsine africana		x	f	x	x	f	x	f
Olea capensis	not characteristic	x	f	C	C	C	x	f
Olea europaea	not characteristic	C	C	C	x	f	C	f
Olinia rochetiana		C	f	C	C	C	C	C
Osyris lanceolata		x	f	f		f	x	
Parinari excelsa	not characteristic				f	C	f	f
Phoenix reclinata	palm species	f	f	x	f	x	f	f
Phytolacca dodecandra		x	f	x	f	f	x	f
Pittosporum viridiflorum		x	f	C	C	x	x	f
Psydrax schimperiana		f	f	x	f	f	x	f
Pterolobium stellatum		f	C	x	f	f	f	f
Rhamnus prinoides		x	C	x	x	f	x	f
Rhoicissus tridentata		f	C	f	x	f	f	f
Rhus longipes		f	f	f	x	f	x	f
Rhus natalensis		f	C	x	f	f	x	f
Rhus vulgaris		f	f	x	f	f	x	f
Ritchiea albersii		x	f	C		x	x	f
Rosa abyssinica		x	C					
Rothmannia urcelliformis		x	f	f	f	f	x	f
Rubus apetalus		x	f	x	f	f	x	f
Rubus volkensii		x	f	x		f	f	
Schefflera abyssinica		x	f	f	x	f	x	f
Schefflera volkensii		x	f	C		f	x	
Schrebera alata	not characteristic	x	C	x	f	C	x	f
Scutia myrtina		x	f	x	f	f	f	f
Senna didymobotrya		f	C	x	f	f	f	f
Shirakiopsis elliptica		f	f	x	f	x	f	f
Sinarundinaria alpina	(Afromontane bamboo)	x	C	f	x	f	f	
Solanecio mannii		f	f	x	f	f	x	f
Syzygium cordatum				f	x	x	f	f
Syzygium guineense	not characteristic	x	f	C	x	x	x	f
Trema orientalis		x	f	x	f	f	x	f
Vangueria apiculata		x	f	f	f	f	x	f
Vangueria madagascariensis		f	C	f	f	f	x	
Vepris dainellii		C	f					
Vepris nobilis		C	C	C	x	f	C	f
Vernonia amygdalina		x	C	f	f	f	x	f
Vernonia myriantha		f	f	f	x	f	x	f
Zanthoxylum usambarense		f	C	C		x		

8. Afromontane single-dominant *Hagenia abyssinica* forest (Fd)

8.1. Description

Hagenia abyssinica is found on most of the higher mountains between Ethiopia and northern Malawi, including Mt. Kenya, Mt. Meru (Tanzania), the Nyika Plateau (Malawi) and the Virunga mountains (Rwanda). Characteristically, *Hagenia abyssinica* forms almost pure stands of 9 to 15 m tall in a narrow and often interrupted zone between the montane Ericaceous belt (E) and taller types of Afromontane rain forest (Fa) or Afromontane undifferentiated forest (Fbu). The best-developed stands are clearly forest, but other stands have a structure that is better described as woodland or scrub forest (White 1983 p. 166).

Some authors have suggested that Afromontane single-dominant *Hagenia abyssinica* forest is a climax vegetation type where low night temperatures exclude other trees. However, even at high altitudes the dominance of *Hagenia abyssinica* is probably still the result from disturbance. The altitudinal range of this species is between 1800 and 3400 m. The abundance of this species does not seem to be related to moisture conditions, although the species is usually absent from Afromontane rain forest (Fa) and taller types of Afromontane undifferentiated forest (White 1983 p. 166).

Figure 8.1. Afromontane single-dominant *Hagenia abyssinica* forest between the Karisimbi and Bisoke volcanoes in the Volcanoes National Park (Rwanda). Photograph by E. Fischer (October 1991)

Figure 8.2. Flowering *Hagenia abyssinica* tree against a background of Afromontane bamboo (*Sinarundinaria alpina*, synonym: *Arundinaria alpina*) n Kahuzi-Biega National Park (D.R.Congo). *Hagenia abyssinica* is also present in other types of Afromontane forest such as Afromontane single-dominant *Juniperus procera* forest (Fbj). Photograph by E. Fischer (October 1991).

8.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country)

Table 8. Species composition of Afromontane single-dominant *Hagenia abyssinica* forest (Fd)

SPECIES	Regional status	Ethiopia (FbuE subtype)	Kenya	Malawi	Rwanda	Tanzania	Uganda
Hagenia abyssinica	dominant	D	C	D	D	D	C
Hypericum revolutum	indicator species	f	C	f	C	f	x
Apodytes dimidiata	characteristic species	f	f	x	f	f	f
Ilex mitis	characteristic species	f	f	C	f	f	f
Kiggelaria africana	characteristic species (species that does not extend as far north as Ethiopia)			C		f	
Nuxia congesta	characteristic species	f	f	x	f	f	f
Nuxia floribunda	characteristic species		f	x	f	f	f
Podocarpus latifolius	characteristic species (species that does not extend as far north as Ethiopia)		f	C	f	f	f
Prunus africana	characteristic species	f	f	C	f	f	x
Rapanea melanophloeos	characteristic species	f	f	C	f	f	x
Xymalos monospora	characteristic species (species that does not extend as far north as Ethiopia)		f	x	f	f	f
Cassipourea malosana	not characteristic	f	f	C		f	f
Cornus volkensii			C	f	f	f	C
Cussonia spicata			f	C		f	f
Lepidotrichilia volkensii		f	C	x	f	f	f
Olea capensis	not characteristic	f	f	C	f	f	f
Olinia rochetiana		f	f	C	f	f	f
Pittosporum viridiflorum		f	f	C	f	f	f
Schefflera volkensii		f	C			f	f

9. Afromontane moist transitional forest (Fe)

9.1. Description

Afromontane moist transitional forest was the only VECEA forest vegetation type that could not be directly related to forest types listed for the Vegetation Map of Africa (White 1983). However, in the description of Afromontane dry transitional forest, White listed two characteristic species that occur near streams (White 1983 pp. 166 - 167). We hypothesize that these two species, *Albizia gummifera* and *Newtonia buchananii*, could be potential indicators of Afromontane moist transitional forest. *Albizia gummifera* is also a characteristic species of Lake Victoria transitional rain forest (Ff; White 1983 p. 181). *Newtonia buchananii* was also listed as characteristic species for Lake Victoria transitional rain forest (Ff; White 1983 p. 181), Zanzibar-Inhambane lowland rain forest (Fo; White 1983 p. 186), Zanzibar-Inhambane transitional rain forest (Fg; White 1983 p. 187) and evergreen and semi-evergreen Zambezian riparian forest (fr; White 1983 p. 91). However, since these two indicator species are not listed for Ethiopia, they are effectively indicators for the Kenyan manifestation of this vegetation type (FeK).

Figure 9.1. Canopy and forest margins of Afromontane moist transitional rain forest (synonym transitional rain forest) in Ethiopia. Approximate altitude of 1200 m. Photograph by I. Friis and Sebsebe Demissew (January 2009). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 28A. 2010.

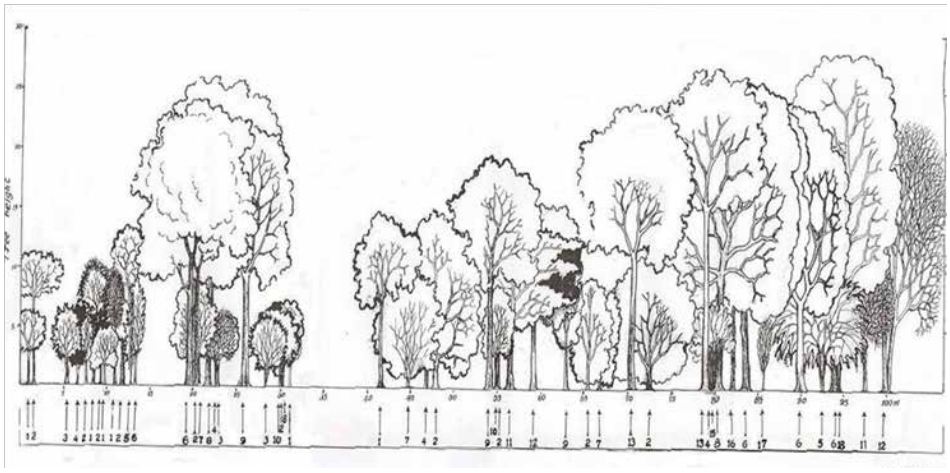

Figure 9.2. Profile diagram of Afromontane moist transitional forest in the Kambakia area north-east of Mt. Kenya (0° 04.498' N; 37° 37.671' E). Altitude 1612 m. This forest was classified by Trapnell *et al.* (1966, 1969, 1976, 1986)) as moist intermediate forest. Species shown are: *Bersama abyssinica* (15); *Casearia battiscombei* (13); *Celtis africana* (8); *Celtis gomphophylla* (12); *Cordia africana* (6); *Croton sylvaticus* (9); *Diospyros abyssinica* (10); *Ehretia cymosa* (5); *Erythrococca bongensis* (3); *Flacourtia indica* (7); *Olea capensis* (16); *Pittosporum viridiflorum* (11); *Ritchiea albersii* (14); *Rothmannia urcelliformis* (1); *Trilepisium madagascariense* (4) and *Xymalos monospora* (2). Obtained from Matingi (2011).

9.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 9 Species composition of Afromontane moist transitional forest (Fe)

SPECIES	Regional status	Ethiopia	Kenya
Acacia abyssinica		f	x
Albizia coriaria		x	f
Albizia grandibracteata		x	f
Albizia gummifera	(probable indicator species as near streams in Afromontane dry transitional forest)	f	C
Albizia schimperiana		C	f
Allophylus abyssinicus		f	x
Allophylus rubifolius		f	x
Alstonia boonei		C	
Anthocleista grandiflora			C
Antiaris toxicaria		C	f
Antidesma venosum		f	x
Aphania senegalensis		x	f
Apodytes dimidiata		f	x
Baphia abyssinica		x	
Bersama abyssinica		f	C
Blighia unijugata		x	C
Bridelia micrantha		f	C
Buddleja polystachya		f	x
Caesalpinia decapetala			x
Caesalpinia volkensii			x
Casearia battiscombei			C
Cassipourea malosana		f	C
Catha edulis		f	x
Ceiba pentandra		x	
Celtis africana		f	x
Celtis gomphophylla		C	C
Celtis mildbraedii			x
Celtis toka		C	
Clausena anisata		f	x
Cordia africana		x	C
Craibia brownii			x
Crateva adansonii		x	f
Crotalaria agatiflora		f	x
Croton macrostachyus		f	C
Croton megalocarpus			C
Croton sylvaticus		C	C
Diospyros abyssinica		C	C
Dombeya torrida		f	x
Dovyalis abyssinica		f	x
Dovyalis macrocalyx			x
Dracaena fragrans		x	f
Dracaena steudneri		x	C
Ehretia cymosa		f	C
Ekebergia capensis		f	C
Elaeodendron buchananii		x	f
Embelia schimperi		f	x
Englerophytum natalense			x
Erythroxylum fischeri		x	f
Eugenia capensis		x	f
Fagaropsis angolensis		x	C
Ficus exasperata		C	C
Ficus mucuso		C	f
Ficus natalensis			x
Ficus platyphylla		x	
Ficus sur		x	C
Ficus thonningii		f	C
Funtumia africana			x
Hagenia abyssinica		f	x
Harungana madagascariensis			C
Kigelia moosa			C
Lannea welwitschii		x	f
Lecaniodiscus fraxinifolius		C	f
Lepidotrichilia volkensii		f	x
Lovoa swynnertonii			C
Macaranga capensis		f	x
Maesa lanceolata		f	x
Manilkara butugii		C	C
Margaritaria discoidea		x	x
Markhamia lutea			C

SPECIES	Regional status	Ethiopia	Kenya
Maytenus undata		f	x
Milicia excelsa		C	C
Mimusops bagshawei			C
Mimusops kummel		f	C
Morus mesozygia		C	f
Myrianthus holstii			C
Neoboutonia macrocalyx			C
Newtonia buchananii	(probable indicator species as near streams in dry transitional forest)		C
Nuxia congesta		f	C
Olea capensis		f	C
Olyra latifolia		x	f
Oncoba spinosa		x	f
Phoenix reclinata	(palm species)	f	x
Phytolacca dodecandra		f	x
Pittosporum viridiflorum		f	x
Plectranthus barbatus		f	x
Polyscias fulva		x	f
Pouteria adolfi-friedericii		f	x
Pouteria altissima		C	f
Premna maxima			C
Prunus africana		f	x
Psychotria mahonii			x
Psydrax parviflora		f	C
Pterolobium stellatum		f	x
Rapanea melanophloeos		f	x
Rauvolfia caffra			C
Rhamnus prinoides		f	x
Rhoicissus revoilii		f	x
Ritchiea albersii		x	f
Rothmannia urcelliformis		x	C
Rubus apetalus		f	x
Rubus volkensii		f	x
Schefflera abyssinica		f	x
Schefflera volkensii		f	x
Scutia myrtina		f	x
Senna didymobotrya		f	x
Senna septemtrionalis			x
Shirakiopsis elliptica		x	C
Smilax anceps		x	f
Solanum aculeastrum			x
Strombosia scheffleri			C
Strychnos mitis		C	f
Syzygium guineense		f	x
Tabernaemontana pachysiphon			C
Tabernaemontana stapfiana			x
Trema orientalis		f	C
Trichilia dregeana		C	f
Trichilia emetica		f	C
Trilepisium madagascariense		C	f
Vepris dainellii		x	
Vepris nobilis		f	C
Vernonia auriculifera		f	x
Vernonia myriantha		f	x
Warburgia ugandensis		f	C
Xylopia parviflora		x	f
Xymalos monospora			x
Zanha golungensis		C	f
Zanthoxylum gilletii		x	C
Zanthoxylum rubescens			C
Ziziphus pubescens		x	f

10. Lake Victoria transitional rain forest (Ff)

10.1. Description

White describes two types of Lake Victoria transitional rain forest: (i) transitional rain forests occurring between 1600 and 1900 m in western Burundi, western Rwanda and eastern Kivu (DRC); and (ii) Kakamega forest in Kenya (1520 to 1680 m). Kakamega forest is described as containing a mixture of Guineo-Congolian lowland rain forest species (that reach their easternmost limits in distribution in Kakamega forest) and Afromontane species, but containing fewer Afromontane species than the other Lake Victoria transitional rain forests (White 1983 p. 181).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Lake Victoria transitional rain forest and no other Lake Victoria forest types) that were listed as characteristic species for one or several national maps include *Alangium chinense* (Afromontane species, also a indicator for Zanzibar-Inhambane transitional rain forest [Ff]), *Anthonotha pynaertii, Apodytes dimidiata* (Afromontane species, also characteristic of Afromontane undifferentiated forest [Fbu] and Afromontane dry transitional forest [Fh]), *Carapa procera, Chrysophyllum gorungosanum* (also a indicator of Afro-montane rain forest [Fa]), *Cordia millenii* (Guineo-Congolian lowland rain forest species), *Diospyros gabunensis, Macaranga capensis* (synonym: *Macaranga kilimandscharica; Afromontane species), Monodora myristica* (Guineo-Congolian lowland rain forest species), *Neoboutonia macrocalyx* (Afromontane species), *Newtonia buchananii* (also a characteristic species of Afromontane moist transitional forest [FeK], Afromontane dry transitional forest [Fh; near streams], Zanzibar-Inhambane lowland rain forest [Fo] and Zanzibar-Inhambane transitional rain forest [Fg; upland species]), *Parinari excelsa* (also an indicator of Afromontane rain forest [Fa]), *Prunus africana* (Afromontane species, also characteristic of Afromontane rain forest [Fa] and Afromontane undifferentiated forest [Fbu]), *Strombosia scheffleri* (Afromontane species, also a indicator of Afromontane rain forest [Fa]), *Symphonia globulifera, Syzygium guineense* (also an indicator of Afromontane rain forest [Fa]), *Turraea holstii* (Afromontane species) and *Xymalos monospora* (also characteristic of Afromontane rain forest [Fa] and Afromontane undifferentiated forest [Fbu]).

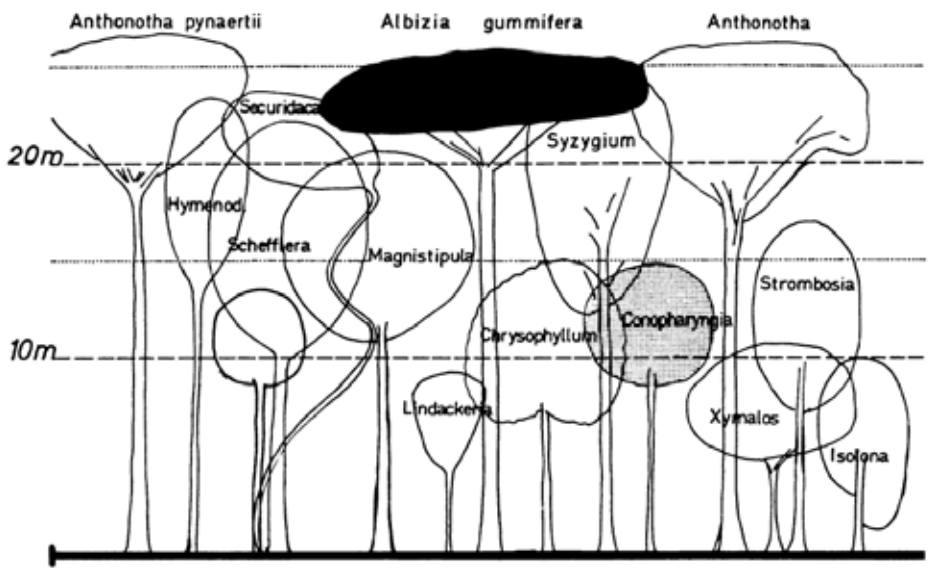

Figure 10.1. Profile diagram of Lake Victoria transitional rain forest in Burundi. Although White (1983 p. 164) listed this profile diagram for the description of Afromontane rain forest (Fa), the altitude range for this forest type of 1600 – 1900 m were described by White (1983 p. 181) for Lake Victoria transitional rain forest (Ff) and also corresponded to the altitude range of the "horizon inférieur" mentioned with the original publication of this profile diagram (Lewalle 1972). Figure obtained from URL: *http://www.jstor.org/stable/3667406*.

Figure 10.2. Lake Victoria transitional rain forest in South Nandi forest. Photograph by F. Gachathi.

10.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 10. Species composition of Lake Victoria transitional rain forest (Ff)

SPECIES	Regional status	Kenya	Rwanda
Alangium chinense	indicator species (Afromontane species)	x	f
Anthonotha pynaertii	indicator species		x
Apodytes dimidiata	indicator species (Afromontane species)	x	x
Carapa procera	indicator species		C
Chrysophyllum gorungosanum	indicator species (Afromontane species)	f	C
Cordia millenii	indicator species (Guineo-Congolian species)	C	
Diospyros gabunensis	indicator species		x
Macaranga capensis	indicator species (Afromontane species)	x	x
Monodora myristica	indicator species (Guineo-Congolian species)	C	
Neoboutonia macrocalyx	indicator species (Afromontane species)	C	C
Newtonia buchananii	indicator species	f	C
Parinari excelsa	indicator species (Afromontane species)		C
Prunus africana	indicator species (Afromontane species)	x	x
Strombosia scheffleri	indicator species (Afromontane species)	C	x
Symphonia globulifera	indicator species		C
Syzygium guineense	indicator species (Afromontane species [*Syzygium guineense* ssp. *afromontanum*])	x	x
Turraea holstii	indicator species (Afromontane species)	C	
Xymalos monospora	indicator species (Afromontane species)	x	x
Albizia gummifera	characteristic species	C	C
Entandrophragma angolense	characteristic species (Guineo-Congolian species)	C	
Maesopsis eminii	characteristic species (Guineo-Congolian species)	C	f
Pouteria altissima	characteristic species (Guineo-Congolian species)	C	x
Acacia abyssinica		x	f
Acacia lahai		x	
Acacia mearnsii		f	x
Agauria salicifolia		f	x
Albizia grandibracteata		C	f
Albizia zygia		C	
Alchornea hirtella		x	x
Allophylus abyssinicus		x	x
Allophylus rubifolius		x	f
Anthocleista grandiflora		C	
Antiaris toxicaria	not characteristic	C	f
Antidesma venosum		x	
Beilschmiedia ugandensis		x	
Bersama abyssinica		C	f
Blighia unijugata		C	f
Bridelia brideliifolia			x
Bridelia micrantha		C	f
Buddleja polystachya		x	
Caesalpinia decapetala		x	f
Caesalpinia volkensii		x	
Casearia battiscombei		C	
Cassipourea malosana		C	
Cassipourea ruwensoriensis		C	x
Celtis africana		x	f
Celtis gomphophylla		C	C
Celtis mildbraedii		C	
Chrysophyllum albidum	not characteristic	C	
Clausena anisata		x	C
Cordia africana		C	f
Craibia brownii		x	f
Crotalaria agatiflora		x	f
Croton macrostachyus		C	x
Croton megalocarpus		C	x
Croton sylvaticus		C	
Cyathea manniana		x	x
Diospyros abyssinica		C	f
Dombeya torrida		x	x
Dovyalis abyssinica		x	
Dovyalis macrocalyx		x	x
Dracaena fragrans		x	f
Dracaena steudneri		C	x

SPECIES	Regional status	Kenya	Rwanda
Ehretia cymosa		C	C
Ekebergia capensis		C	x
Embelia schimperi		x	x
Ensete ventricosum		f	x
Entada abyssinica		x	f
Entandrophragma excelsum			C
Eugenia capensis		f	x
Fagaropsis angolensis		C	x
Ficalhoa laurifolia			x
Ficus exasperata		C	x
Ficus natalensis		x	f
Ficus sur		C	x
Ficus thonningii		C	f
Funtumia africana		C	
Galiniera saxifraga		x	x
Garcinia buchananii		C	f
Hagenia abyssinica		x	x
Harungana madagascariensis		C	C
Hypericum revolutum		f	x
Ilex mitis		f	x
Kigelia africana		f	x
Kigelia moosa		C	
Lecaniodiscus fraxinifolius		C	
Lepidotrichilia volkensii		x	x
Lovoa trichilioides			x
Maesa lanceolata		x	x
Manilkara butugii		C	
Margaritaria discoidea		x	
Markhamia lutea		C	f
Maytenus acuminata		f	x
Maytenus undata		x	x
Milicia excelsa	not characteristic	C	f
Mimusops bagshawei		C	f
Mimusops kummel		C	
Mondia whitei		x	
Morus mesozygia	not characteristic	C	
Nuxia congesta		C	x
Nuxia floribunda		f	x
Ocotea kenyensis		f	x
Ocotea usambarensis		f	x
Olea capensis		C	f
Olinia rochetiana		f	x
Peddiea fischeri		f	x
Phoenix reclinata	(palm species)	x	f
Phytolacca dodecandra		x	f
Pittosporum viridiflorum		x	x
Plectranthus barbatus		x	
Pleiocarpa pycnantha		f	x
Podocarpus falcatus		f	x
Podocarpus latifolius		f	x
Polyscias fulva		C	x
Pouteria adolfi-friedericii		x	f
Pseudospondias microcarpa		C	x
Psychotria mahonii		x	x
Psydrax parviflora		C	f
Pterolobium stellatum		x	f
Rapanea melanophloeos		x	x
Rhamnus prinoides		x	x
Rinorea angustifolia		f	x
Ritchiea albersii		x	x
Rothmannia urcelliformis		C	
Rubus apetalus		x	x
Rubus volkensii		x	

SPECIES Regional status	Kenya	Rwanda
Schefflera abyssinica	x	
Schefflera volkensii	x	
Schrebera alata	fh	x
Scutia myrtina	x	f
Senna didymobotrya	x	f
Senna septemtrionalis	x	f
Shirakiopsis elliptica	C	C
Smilax anceps	f	x
Solanum aculeastrum	x	x
Spathodea campanulata	C	f
Sterculia dawei	x	
Tabernaemontana pachysiphon	C	
Tabernaemontana stapfiana	x	x
Trema orientalis	C	x
Trichilia dregeana	C	
Trichilia emetica	C	
Trilepisium madagascariense	C	
Vangueria apiculata	f	x
Vepris nobilis	C	x
Vernonia amygdalina	x	f
Vernonia auriculifera	x	f
Vernonia myriantha	x	x
Warburgia ugandensis	C	
Zanthoxylum gilletii	C	x
Zanthoxylum rubescens	C	

11. Afromontane dry transitional forest (Fh)

11.1. Description

Afromontane dry transitional forest occurs on the drier lower slopes of those East African mountains and uplands which rise from the plains covered with Somalia-Masai bushlands (Bd and Be, volume 4). Afromontane and non-afromontane species occur together within these forests. Only small fragments remain and there is little published information (White 1983 p. 166).

Remnants of Afromontane dry transitional forest occur near Nairobi at altitudes between 1650 and 1800 m and annual rainfall around 800 mm (White 1983 p. 166).

Regional indicator species (characteristic species listed by White (1983) that were only provided for Afromontane dry transitional rain forest and no other Afromontane forest types) that were listed as characteristic species for one or several national maps (' indicators', see section 3.2) include *Calodendrum capense* (a species that also occurs as stunted individuals at higher altitudes in evergreen bushland [Be]), *Cassipourea malosana*, *Chaetacme aristata*, *Chrysophyllum viridifolium*, *Croton megalocarpus*, *Euclea divinorum*, *Fagaropsis angolensis*, *Markhamia lutea*, *Olea europaea* **ssp.** *cuspidata*, (synonym: *Olea africana*), *Schrebera alata* (a species that also occurs as stunted individuals at higher altitudes in evergreen bushland [Be]), *Strychnos usambarensis*, *Suregada procera*, *Trichocladus ellipticus*, *Uvariodendron anisatum* and *Warburgia ugandensis*. *Albizia gummifera and Newtonia buchananii* were listed as characteristic species that occur near streams. We hypothesize that these can therefore be categorized as indicator species for Afromontane moist transitional forest (FeK).

White (1983 p. 129) also describes rain-fed dry evergreen forest that occurs as relicts within the greater Serengeti region. The main canopy of this forest consists of *Diospyros abyssinica* (also characteristic of Afromontane dry transitional forest near Nairobi), *Drypetes gerrardii* (also characteristic of Afromontane dry transitional forest near Nairobi), *Elaeodendron buchananii*, *Lecaniodiscus fraxinifolius*, *Suregada procera* (an indicator for Afromontane dry transitional forest near Nairobi), and *Vepris nobilis* (White mentions that *Vepris* [syn. *Teclea*] species are characteristic of Afromontane dry transitional forest near Nairobi). Less frequent constituents of the main canopy include *Chaetacme anisata* (an indicator of Afromontane dry transitional forest near Nairobi), *Euclea divinorum* (an indicator of Afromontane dry transitional forest near Nairobi), *Olea europaea* ssp. *cuspidata* (synonym: *Olea africana*, an indicator of Afromontane dry transitional forest near Nairobi) and *Schrebera alata* (an indicator of Afromontane dry transitional forest near Nairobi). *Capparis erythrocarpos*, *Croton dichogamus* and *Vepris trichocarpa* are the most common species of the understorey. This similarity in species composition and environmental conditions lead us to include this forest into Afromontane dry transitional forests.

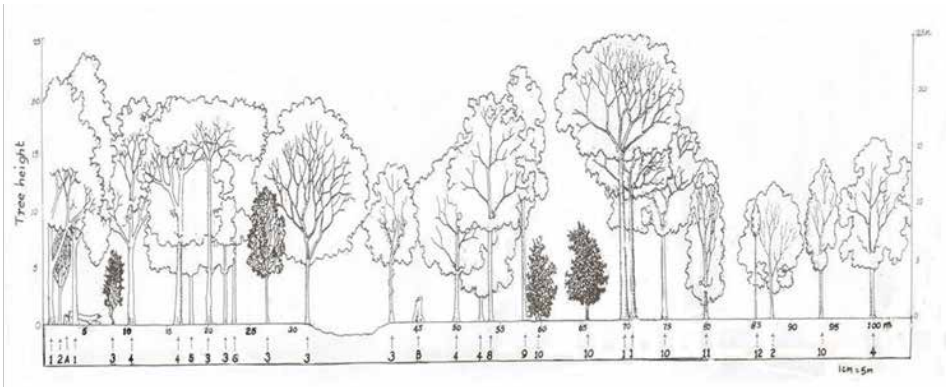

Figure 11.1. Profile diagram of Afromontane dry transitional forest in the Kithoka area north-east of Mt. Kenya (0° 08.065' N; 37° 39.564' E). Altitude 1514 m. This forest was classified by Trapnell *et al*. (1966, 1969, 1976, 1986) as dry intermediate forest. Species shown are: *Calodendrum capense* (4); *Celtis africana* (1); *Croton megalocarpus* (8); *Ehretia cymosa* (11); unidentified *Ficus sp* (9); *Olea europaea* (10, B); *Pittosporum viridiflorum* (3, A); *Ritchiea albersii* (5); *Strychnos henningsii* (12); *Uvariodendron anisatum* (2); *Vepris simplicifolia* (7) and *Vepris trichocarpa* (6). Obtained from Matingi (2011).

11.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 11. Species composition of Afromontane dry transitional forest (Fh)

SPECIES	Regional status	Kenya	Tanzania
Albizia gummifera	indicator species (but near streams)	C	C
Calodendrum capense	indicator species	C	f
Cassipourea malosana	indicator species	C	f
Chaetachme aristata	indicator species	x	f
Chrysophyllum viridifolium	indicator species	C	
Croton megalocarpus	indicator species	C	f
Euclea divinorum	indicator species	C	f
Fagaropsis angolensis	indicator species	C	f
Margaritaria discoidea	indicator species	C	C
Markhamia lutea	indicator species	C	f
Newtonia buchananii	indicator species (but near streams)	x	f
Olea europaea	indicator species (*Olea europaea* ssp. *cuspidata* , synonym: *Olea africana*)	C	f
Schrebera alata	indicator species	C	f
Strychnos usambarensis	indicator species	x	f
Suregada procera	indicator species	x	f
Trichocladus ellipticus	indicator species	x	f
Uvariodendron anisatum	indicator species	C	
Warburgia ugandensis	indicator species	C	f
Apodytes dimidiata	characteristic species	x	f
Diospyros abyssinica	characteristic species	C	f
Drypetes gerrardii	characteristic species	C	C
Elaeodendron buchananii	characteristic species (dry evergreen forest in the greater Serengeti region)	C	f
Vepris trichocarpa	characteristic species in dry evergreen forest in the greater Serengeti region	C	f
Acacia brevispica		x	f
Acokanthera oppositifolia		x	
Acokanthera schimperi		C	f
Albizia schimperiana		C	f
Allophylus abyssinicus		x	f
Allophylus rubifolius		x	f
Antidesma venosum		x	f
Aphania senegalensis		x	f
Bersama abyssinica		C	x
Blighia unijugata		x	f
Brachylaena huillensis		C	f
Bridelia micrantha		C	f
Bridelia scleroneura		x	f
Caesalpinia decapetala		x	f
Caesalpinia volkensii		x	f
Carissa spinarum		x	f
Catha edulis		x	f
Celtis africana		x	f
Clausena anisata		x	f
Clerodendrum myricoides		x	f
Combretum schumannii		x	f
Commiphora eminii		x	f
Cordia africana		x	f
Cornus volkensii		x	f
Craibia brownii		C	f
Crateva adansonii		x	f
Crotalaria agatiflora		x	f
Croton macrostachyus		C	f
Cussonia spicata		x	f
Dodonaea viscosa		x	f
Dombeya kirkii		x	f
Dovyalis abyssinica		x	f
Dovyalis macrocalyx		x	f
Dracaena steudneri		C	f
Ehretia cymosa		C	
Ekebergia benguelensis		x	f
Ekebergia capensis		C	f
Englerophytum natalense		x	f
Euclea racemosa		x	f
Euphorbia abyssinica		x	f
Euphorbia candelabrum		x	f
Ficus natalensis		x	f
Ficus sur		C	f
Ficus thonningii		C	f
Filicium decipiens		x	f
Flacourtia indica		x	f

SPECIES	Regional status	Kenya	Tanzania
Flueggea virosa		x	f
Grewia similis		x	f
Ilex mitis	not characteristic	x	f
Indigofera swaziensis		x	f
Juniperus procera		x	f
Kigelia moosa		x	f
Lannea schweinfurthii		x	f
Lepidotrichilia volkensii		x	f
Manilkara sulcata		x	f
Maytenus arbutifolia		x	f
Maytenus undata		x	f
Meyna tetraphylla		x	f
Mimusops bagshawei		C	f
Mimusops kummel		C	f
Myrsine africana		x	f
Nuxia congesta	not characteristic	C	f
Nuxia floribunda	not characteristic	x	f
Olea capensis	not characteristic	x	f
Olinia rochetiana		x	f
Osyris lanceolata		x	f
Pappea capensis		x	f
Pavetta oliveriana		x	f
Phoenix reclinata	(palm species)	x	f
Phytolacca dodecandra		x	f
Pistacia aethiopica		x	f
Pittosporum viridiflorum		x	f
Plectranthus barbatus		x	f
Podocarpus falcatus	not characteristic	x	f
Podocarpus latifolius	not characteristic	x	f
Podocarpus usambarensis		x	f
Psydrax schimperiana		C	f
Pterolobium stellatum		x	f
Rapanea melanophloeos	not characteristic	x	f
Rhamnus staddo		x	f
Rhoicissus revoilii		x	f
Rhus natalensis		x	f
Rhus vulgaris		x	f
Ritchiea albersii		x	f
Rothmannia urcelliformis		C	f
Rubus apetalus		x	f
Rubus volkensii		x	f
Schefflera volkensii		x	f
Scutia myrtina		x	f
Senecio hadiensis		x	f
Senna didymobotrya		x	f
Senna septemtrionalis		x	f
Shirakiopsis elliptica		C	f
Solanecio cydoniifolius		x	f
Solanecio mannii		x	f
Solanum aculeastrum		x	f
Sorindeia madagascariensis		x	f
Stereospermum kunthianum		x	f
Strychnos henningsii		C	f
Strychnos innocua		x	f
Strychnos mitis		C	x
Synsepalum brevipes		x	f
Syzygium guineense	not characteristic	x	f
Tarenna graveolens		x	f
Trema orientalis		C	f
Uvaria scheffleri		x	f
Vangueria apiculata		x	f
Vangueria infausta		x	f
Vangueria madagascariensis		x	f
Vepris nobilis	characteristic genus, characteristic species in dry evergreen forest in the greater Serengeti region	C	f
Vepris simplicifolia		C	f
Vernonia auriculifera		x	f
Zanthoxylum chalybeum		x	f
Zanthoxylum usambarense		x	f

12. Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)

12.1. Description

White (1983 p. 46) restricted semi-evergreen forests to forests where some canopy species are briefly deciduous, but not necessarily at the same time, and most members of the understorey are evergreen.

The Lake Victoria regional mosaic consists of floristically impoverished variants of the characteristic vegetation types of the Guineo-Congolian, Sudanian, Zambezian and Somalia-Masai regional centres of endemism, sometimes with an admixture from Afromontane species (White 1983 p. 181). Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest is therefore expected to be a floristically impoverished variant of drier peripheral semi-evergreen Guineo-Congolian rain forests described for the Guineo-Congolian region (White 1983 p. 79). Most of the species of secondary grassland and wooded grassland in the Lake Victoria region also occur in Guineo-Congolian secondary grassland (White 1983 p. 181).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest and no other Lake Victoria forest type) that were listed as characteristic species for one or several national maps include *Alstonia boonei*, *Antiaris toxicaria*, *Chrysophyllum albidum*, *Entandrophragma cylindricum*, *Entandrophragma utile*, *Holoptelea grandis*, *Khaya anthotheca*, *Khaya grandifoliola*, *Mildbraediodendron excelsum*, *Milicia excelsa*, *Morus mesozygia*, *Piptadeniastrum africanum* and *Pycnanthus angolensis*.

Figure 12.1. Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest on Bukasa Island (Ssese Islands, Uganda). Species shown include *Newtonia buchananii* and *Uapaca guineensis*. In the Uganda national map, this forest type was classified as *Piptadeniastrum - Uapaca* forests (C1). Thomas 1941. Image obtained from URL: *http://www.jstor.org/stable/2256396*

Figure 12.2. Profile diagram of Ironwood forest in Budongo (Uganda). This forest type was classified as Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest in the VECEA map and as *Cynometra - Celtis* forest (D2) in the Uganda national map. Characteristic species include *Cynometra alexandri* ("Cyn" in the figure; ironwood) and *Celtis zenkeri* ("Cz" in the figure). Eggeling 1947. Image obtained from URL: *http://www.jstor.org/stable/2256760*

Figure 12.3. Profile diagram of mixed forest in Budongo (Uganda). This forest type may represent a successional stage towards *Cynometra - Celtis* forest (D2; see Figure 11.2). Emergent species include: *Alstonia congensis* ("Ac"), *Khaya anthotheca* ("Kh") and *Mildbraediodendron excelsum* ("Ml"). Eggeling 1947. Image obtained from URL: *http://www.jstor.org/stable/2256760.*

12.2. Species composition

(P.lease check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 12. Species composition of Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)

SPECIES	Regional status	Kenya	Tanzania	Uganda (LC1U subtype)	Uganda (LC2U subtype)	Uganda (LC3U subtype)	Uganda (LD1U subtype)	Uganda (LD2U subtype)	Uganda (LD3U subtype)	Uganda (LD4U subtype)
Alstonia boonei	indicator species			f	f	f	C	C	f	C
Antiaris toxicaria	indicator species	f	f	C	C	f	C	x	C	C
Chrysophyllum albidum	indicator species	f		f	C	C	C	x	f	f
Entandrophragma cylindricum	indicator species			f	C	f	f	C	f	f
Entandrophragma utile	indicator species			f	C	f	C	C	f	f
Holoptelea grandis	indicator species			f	x	f	C	C	f	f
Khaya anthotheca	indicator species		f	f	f	f	f	C	f	f
Khaya grandifoliola	indicator species			f	f	f	f	C	f	f
Mildbraediodendron excelsum	indicator species			f	f	f	C	C	f	f
Milicia excelsa	indicator species	f	f	f	x	f	f	x	f	C
Morus mesozygia	indicator species	f	f	f	C	f	f	x	f	f
Piptadeniastrum africanum	indicator species			C	C	f	f	x	f	f
Pycnanthus angolensis	indicator species		f	C	C	f	f	x	f	f
Cynometra alexandri	characteristic species		f	f	f	f	f	C	f	f
Entandrophragma angolense	characteristic species	f	f	f	C	f	C	C	f	f
Maesopsis eminii	characteristic species	f	f	C	C	C	C	C	f	f
Pouteria altissima	characteristic species	f	f	f	C	C	f	x	f	f
Albizia coriaria		f	f	f	f	f	C	f	C	C
Albizia glaberrima		f	f	f	C	f	C	x	f	C
Albizia grandibracteata		f	f	f	C	f	C	C	C	C
Albizia gummifera		f	f	f	C	C	f	x	C	f
Albizia zygia		f	f	f	C	f	C	x	f	C
Balanites wilsoniana		f	f	f	x	f	f	C	f	f
Beilschmiedia ugandensis			f	f	x	f	f	x	f	f
Blighia unijugata		f	f	f	x	f	x	x	C	f
Bombax buonopozense				f	f	f	f	C	f	f
Canarium schweinfurthii			f	C	x	f	f	x	f	C
Cassipourea ruwensoriensis		f	f	f	f	x	f	x	f	f
Celtis adolfi-fridericii	characteristic genus			f	f	f	x	C	f	f
Celtis africana	characteristic genus	f	f	f	C	f	C	C	C	C
Celtis gomphophylla	characteristic genus	f	f	f	C	f	C	x	f	f
Celtis mildbraedii	characteristic genus	f	f	f	C	f	C	C	f	f
Celtis philippensis	characteristic genus	f	f	f	f	f	C	x	f	f
Celtis zenkeri	characteristic genus		f	f	C	f	C	C	f	C
Chrysophyllum gorungosanum		f	f	f	f	C	f	f	f	f
Clausena anisata		f	f	f	x	f	x	x	x	x
Croton macrostachyus		f	f	f	x	f	f	x	C	C
Croton megalocarpus		f	f	f	f	C	f	x	f	f
Diospyros abyssinica		f	f	f	x	x	C	x	f	x
Dombeya kirkii		f	f	f	f	x	x	x	f	f
Dracaena fragrans		f	f	x	x	f	x	f	f	f
Entandrophragma excelsum			f	f	x	C	f	f	f	f
Erythrina excelsa		f	f	f	x	f	f	x	f	f
Erythrophleum suaveolens		f	f	f	f	f	C	C	f	f
Fagaropsis angolensis		f	f	f	x	f	f	x	C	C
Ficus mucuso		f	f	f	C	f	f	x	f	f
Flueggea virosa		f	f	f	x	f	f	x	f	x
Funtumia africana		f	f	x	x	x	C	x	f	f
Funtumia elastica				f	f	f	C	x	f	f
Hallea stipulosa				f	x	f	f	x	f	f
Harrisonia abyssinica		f	f	f	f	f	f	x	f	x
Lannea welwitschii		f	f	f	x	f	f	x	f	f
Lovoa swynnertonii		f	f	f	x	C	f	x	f	f
Lovoa trichilioides			f	C	C	f	f	x	f	f
Maesa lanceolata		f	f	f	x	x	f	x	f	f
Manilkara dawei			f	f	x	f	f	x	f	f
Margaritaria discoidea		f	f	f	x	f	f	C	C	C
Markhamia lutea		f	f	f	x	f	x	x	C	C
Mimusops bagshawei		f	f	C	C	f	C	x	f	C
Morinda lucida			f	f	x	f	f	x	f	f
Myrianthus arboreus			f	f	f	f	f	x	f	f
Nauclea diderrichii				f	f	f	f	x	f	f
Newtonia buchananii		f	f	C	f	C	f	x	f	f
Olea capensis		f	f	f	f	C	f	C	C	f

SPECIES	Regional status	Kenya	Tanzania	Uganda (LC1U subtype)	Uganda (LC2U subtype)	Uganda (LC3U subtype)	Uganda (LD1U subtype)	Uganda (LD2U subtype)	Uganda (LD3U subtype)	Uganda (LD4U subtype)
Parinari excelsa			f	f	C	C	f	x	f	f
Pleiocarpa pycnantha		f	f	f	x	x	f	x	f	f
Polyscias fulva		f	f	x	x	x	f	x	C	f
Prunus africana		f	f	f	x	C	f	x	C	C
Pseudospondias microcarpa		f	f	C	x	f	f	x	f	C
Pterolobium stellatum		f	f	f	x	f	x	x	f	f
Pterygota mildbraedii			f	f	f	f	f	C	f	f
Raphia farinifera	(palm species)	f	f	f	x	f	f	x	f	f
Rauvolfia vomitoria			f	f	x	f	f	x	f	f
Schrebera arborea		f		f	f	f	C	C	f	f
Scutia myrtina		f	f	f	f	f	x	x	f	x
Shirakiopsis elliptica		f	f	f	x	C	f	x	C	C
Strombosia scheffleri		f	f	f	x	C	f	x	f	f
Strychnos mitis		f	f	f	x	f	C	C	f	f
Symphonia globulifera			f	C	x	C	f	x	f	f
Synsepalum brevipes		f	f	C	x	f	x	x	f	f
Tabernaemontana pachysiphon		f	f	x	x	f	f	x	f	f
Trema orientalis		f	f	f	x	x	f	x	f	f
Trichilia dregeana		f	f	C	x	f	f	C	f	f
Trilepisium madagascariense		f	f	x	x	f	C	x	f	f
Uapaca guineensis	(one of the more important species of Lake Victoria swamp forest)		f	C	f	f	f	f	f	f
Vepris nobilis		f	f	f	x	f	C	x	x	C
Vernonia amygdalina		f	f	f	x	f	f	x	x	f
Vernonia auriculifera		f	f	f	f	f	f	f	x	C
Warburgia ugandensis		f	f	f	f	f	C	x	f	f
Xylopia aethiopica		f	f	x	f	f	f	x	f	f
Zanthoxylum gilletii		f	f	f	x	f	f	x	f	f

13. Zanzibar-Inhambane undifferentiated forest (Fp)

13.1. Description

White (1983) reserved the term of "undifferentiated forests" to forests that undergo rapid and kaleidoscopic changes in structure and species composition over short distances (White 1983 p. 47).

A distinction can be made between moister and drier variants of Zanzibar-Inhambane undifferentiated forest:

- The moister variants have a main canopy at 15 to 20 m with emergents of 30 to 35 m. Many of the canopy species are briefly deciduous, although not concurrently, but appreciably more deciduous than semi-evergreen lowland rain forests (*e.g.,* Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest [Fi]). The floristically richest types of moister variants of Zanzibar-Inhambane undifferentiated forests occur in Kenya and northern Tanzania (White 1983 p. 187).
- The drier forest variants are floristically more diverse than the moister variants. Most of the larger tree species are locally dominant or co-document and sometimes gregarious. The drier forests cover a larger area than the moister forests and also extend further to the north and south (White 1983 p. 187).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Zanzibar-Inhambane undifferentiated forest and no other Zanzibar-Inhambane forest type) that were listed as characteristic species for one or several national maps can be further classified as characteristic species only listed for moister forest variants, only listed for drier forest variants or listed for both moister and drier variants:

- Characteristic species for moister forest variants: *Albizia adianthifolia*, *Apodytes dimidiata* (also characteristic of Afromontane undifferentiated forest [Fbu], Afromontane dry transitional forest [Fh] and Lake Victoria transitional rain forest [Ff]), *Bombax rhodognaphalon*, *Celtis philippensis*, *Cola clavata*, *Diospyros abyssinica* (also a characteristic species of Afromontane rain forest [Fa] and Afromontane dry transitional forest [Fh]), *Erythrina sacleuxii*, *Erythrophleum suaveolens*, *Fernandoa magnifica*, *Ficus vallis-choudae*, *Inhambanella henriquesii*, *Lannea welwitschii*, *Malacantha alnifolia*, *Mimusops aedificatoria*, *Nesogordonia holtzii*, *Paramacrolobium coeruleum*, *Synsepalum brevipes* and *Xylopia parviflora*.
- Characteristic species for drier forest variants: *Acacia robusta*, *Albizia petersiana*, *Brachylaena huillensis*, *Cassipourea euryoides*, *Cussonia zimmermannii*, *Cynometra webberi*, *Manilkara sulcata*, *Oldfieldia somalensis*, *Pleurostylia africana*, *Scorodophloeus fischeri*, *Tamarindus indica* and *Warneckea sansibarica*.

- Characteristic species both for moister and drier forest variants: *Afzelia quanzensis, Balanites wilsoniana, Combretum schumannii, Hymenaea verrucosa, Julbernardia magnistipulata, Manilkara sansibarensis and Newtonia paucijuga.*

More information on coastal forests can be obtained from URL http://coastalforests.tfcg.org/ (last accessed June 2011).

13.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 13. Species composition of Zanzibar-Inhambane undifferentiated forest (Fp)

SPECIES	Regional status	Coast (FplC subtype)	Coast (FpdC subtype)	Coast (FpmC subtype)	Coast (secondary WsC subtype)
Acacia robusta	indicator species (drier forest variants)	f	x		
Afzelia quanzensis	indicator species (moister and drier forest variants)	C	C	f	
Albizia adianthifolia	indicator species (moister forest variants)	C	C	f	
Albizia petersiana	indicator species (drier forest variants)	C	C		
Apodytes dimidiata	indicator species (moister forest variants)			f	
Balanites wilsoniana	indicator species (moister and drier forest variants)		C	f	
Bombax rhodognaphalon	indicator species (moister forest variants)		C	C	
Brachylaena huillensis	indicator species (drier forest variants)	x	C		
Cassipourea euryoides	indicator species (drier forest variants)	x	C		
Celtis philippensis	indicator species (moister forest variants)		x	C	
Cola clavata	indicator species (moister forest variants)		C	f	
Combretum schumannii	indicator species (moister and drier forest variants)		C	x	
Cussonia zimmermannii	indicator species (drier forest variants)	f	C	C	
Cynometra webberi	indicator species (drier forest variants)	C	x		
Diospyros abyssinica	indicator species (moister forest variants, but very rare)		x	C	
Erythrina sacleuxii	indicator species (moister forest variants)	C	x	x	
Erythrophleum suaveolens	indicator species (moister forest variants)	C	C	C	
Fernandoa magnifica	indicator species (moister forest variants)		C	C	
Ficus vallis-choudae	indicator species (moister forest variants)			f	
Hymenaea verrucosa	indicator species (moister and drier forest variants)	C	C	x	
Inhambanella henriquesii	indicator species (moister forest variants)		C	f	
Julbernardia magnistipulata	indicator species (moister and drier forest variants)	C	C	x	
Lannea welwitschii	indicator species (moister forest variants)		x	f	
Malacantha alnifolia	indicator species (moister forest variants)			f	
Manilkara sansibarensis	indicator species (moister and drier forest variants)	x	C	f	
Manilkara sulcata	indicator species (drier forest variants)	x	C		
Mimusops aedificatoria	indicator species (moister forest variants)			x	
Nesogordonia holtzii	indicator species (moister forest variants)	x	C	x	
Newtonia paucijuga	indicator species (moister and drier forest variants)	f	C	C	
Oldfieldia somalensis	indicator species (drier forest variants)	x	x		
Paramacrolobium coeruleum	indicator species (moister forest variants)	C	x	x	
Pleurostylia africana	indicator species (drier forest variants)		x		
Scorodophloeus fischeri	indicator species (drier forest variants)	C	C	C	
Synsepalum brevipes	indicator species (moister forest variants)	x	C	C	
Tamarindus indica	indicator species (drier forest variants)		C		
Warneckea sansibarica	indicator species (drier forest variants)	f	f		
Xylopia parviflora	indicator species (moister forest variants)		C	C	
Antiaris toxicaria	characteristic species (moister forest variants)		C	C	
Cordyla africana	characteristic species (moister forest variants)		C	C	
Diospyros mespiliformis	characteristic species (moister forest variants)		C	x	
Lovoa swynnertonii	characteristic species (moister forest variants)		x	x	
Macaranga capensis	characteristic species (moister forest variants)		x	f	
Milicia excelsa	characteristic species (moister and drier forest variants)		C	C	x
Parkia filicoidea	characteristic species (moister forest variants)		x	C	
Ricinodendron heudelotii	characteristic species (moister forest variants)	x	C	C	
Sterculia appendiculata	characteristic species (moister and drier forest variants)		C	C	x
Terminalia sambesiaca	characteristic species (moister forest variants)		C	x	
Trilepisium madagascariense	characteristic species (moister and drier forest variants)		C	x	
Acacia polyacantha			C		
Acacia senegal	(secondary grassland and wooded grassland)				x
Adansonia digitata	probably introduced by humans and does not regenerate under a closed forest canopy		C		x
Albizia glaberrima		x	C	x	
Albizia gummifera		x	C	x	
Albizia versicolor			C		
Annona senegalensis	(secondary grassland and wooded grassland)				x
Anthocleista grandiflora			C	C	
Antidesma venosum	(secondary grassland and wooded grassland)				x
Bersama abyssinica			C	x	
Blighia unijugata			x	C	
Borassus aethiopum	(secondary grassland and wooded grassland)				x
Brachystegia spiciformis			C		

SPECIES	Regional status	Coast (FplC subtype)	Coast (FpdC subtype)	Coast (FpmC subtype)	Coast (secondary WsC subtype)
Celtis gomphophylla			C	f	
Celtis mildbraedii			x	x	
Crossopteryx febrifuga	(secondary grassland and wooded grassland)				x
Croton sylvaticus			C	x	
Dalbergia melanoxylon	(secondary grassland and wooded grassland)				x
Dialium orientale			C		
Dichrostachys cinerea	(secondary grassland and wooded grassland)				x
Ekebergia capensis		x	C	C	
Elaeis guineensis	(palm species)		x	C	
Encephalartos hildebrandtii	cycad species that is locally plentiful in drier forest variants		f		
Englerophytum natalense				C	
Fagaropsis angolensis			C		
Ficus sur			C		
Flacourtia indica	(secondary grassland and wooded grassland)		C		x
Funtumia africana	not characteristic		C	C	
Garcinia buchananii		x	C		
Garcinia livingstonei			C	x	
Harrisonia abyssinica	(secondary grassland and wooded grassland)				x
Hyphaene compressa	(secondary grassland and wooded grassland, palm species)				x
Khaya anthotheca	not characteristic	x	C	C	
Lannea schweinfurthii	(secondary grassland and wooded grassland)		C		x
Lecaniodiscus fraxinifolius			C	x	
Markhamia obtusifolia		x	x		
Markhamia zanzibarica			C		
Maytenus senegalensis	(secondary grassland and wooded grassland)				x
Mimusops obtusifolia			C		
Monodora grandidieri			C		
Newtonia buchananii	not characteristic	C	C	C	
Parinari excelsa			C		
Piliostigma thonningii	(secondary grassland and wooded grassland)				x
Pterocarpus tinctorius			C		
Sclerocarya birrea	(secondary grassland and wooded grassland)				x
Securidaca longipedunculata	(secondary grassland and wooded grassland)				x
Sideroxylon inerme	not characteristic		C		
Sorindeia madagascariensis		x	C	C	
Stereospermum kunthianum	(secondary grassland and wooded grassland)				x
Strychnos henningsii		x	C		
Strychnos mitis	not characteristic		x	x	
Strychnos spinosa	(secondary grassland and wooded grassland)				x
Syzygium cordatum			C		
Syzygium guineense			C		
Tabernaemontana pachysiphon			C	C	
Trema orientalis			C		
Trichilia emetica			C	C	
Vitex doniana			x	C	
Vitex mombassae	(secondary grassland and wooded grassland)				x
Zanha golungensis			x	C	
Zanthoxylum chalybeum			C		
Ziziphus pubescens			C		

14. Zanzibar-Inhambane scrub forest (Fq)

14.1. Description

Zanzibar-Inhambane scrub forest forms a quasi-continuous belt that separates the forests of the coastal region (*i.e.* Zanzibar-Inhambane undifferentiated forest [Fp]) from the bushlands of the interior (*i.e.* especially deciduous bushland [Bd]). This forest reaches the Kenyan coast between Malindi and Lamu, where the rainfall is lower than elsewhere, and extends to southern Tanzania. *Diospyros cornii* forms a discontinuous upper canopy of 9 to 15 m high. *Manilkara mochisia* is an almost constant associate, but is less plentiful. In many places, scrub forest has been degraded and converted into secondary deciduous bushland (White 1983 p. 188). *Diospyros cornii* and *Manilkara mochisia* are also emergent trees on termite mounds within Zanzibar-Inhambane edaphic grassland (White 1983 p. 189).

The annual rainfall is between 500 and 750 mm (White 1983 p. 188). Besides the dominant *Diospyros cornii* and *Manilkara mochisia*, regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Zanzibar-Inhambane scrub forest and no other Zanzibar-Inhambane forest types) that were listed as characteristic species for the national maps include *Adenia globosa, Bivinia jalbertii, Catunaregam nilotica, Croton pseudopulchellus, Diospyros consolatae, Dobera glabra* (abundant especially where the water-table is near the surface), *Euclea natalensis, Euclea racemosa, Euphorbia candelabrum* (rare), *Euphorbia grandicornis, Grandidiera boivinii, Haplocoelum foliolosum, Haplocoelum inoploeum, Newtonia erlangeri* (only in northern scrub forests), *Ochna thomasiana, Sideroxylon inerme, Spirostachys venenifera, Suregada zanzibariensis, Thespesia danis* and *Thylachium africanum*.

14.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 14. Species composition of Zanzibar-Inhambane scrub forest (Fq)

SPECIES	Regional status	Coast
Diospyros cornii	dominant	D
Manilkara mochisia	dominant	D
Adenia globosa	indicator species	x
Bivinia jalbertii	indicator species	f
Catunaregam nilotica	indicator species	f
Croton pseudopulchellus	indicator species	x
Diospyros consolatae	indicator species	x
Dobera glabra	indicator species (abundant especially where the water-table is near the surface)	f
Euclea natalensis	indicator species	x
Euclea racemosa	indicator species	f
Euphorbia candelabrum	indicator species (rare and often absent)	f
Euphorbia grandicornis	indicator species (dense communities in the understorey)	f
Grandidiera boivinii	indicator species	f
Haplocoelum foliolosum	indicator species	f
Haplocoelum inoploeum	indicator species	x
Newtonia erlangeri	indicator species (only in northern forests)	x
Ochna thomasiana	indicator species	f
Sideroxylon inerme	indicator species	f
Spirostachys venenifera	indicator species	x
Suregada zanzibariensis	indicator species	x
Thespesia danis	indicator species	x
Thylachium africanum	indicator species	x
Acacia brevispica		x
Acacia bussei	secondary species	f
Acacia mellifera	secondary species	f
Acacia nilotica	secondary species	f
Afzelia quanzensis	not characteristic	x
Albizia adianthifolia	not characteristic	x
Albizia anthelmintica	secondary species	x
Albizia petersiana	not characteristic	x
Albizia versicolor		x
Allophylus rubifolius		x
Bombax rhodognaphalon	not characteristic	x
Boscia salicifolia		x
Brachylaena huillensis	not characteristic	x
Carissa spinarum		x
Combretum schumannii	not characteristic	x
Cordyla africana	not characteristic	x
Dalbergia nitidula		x
Dialium orientale		x
Diospyros mespiliformis	not characteristic	x
Euphorbia tirucalli		x
Garcinia livingstonei		x
Grewia villosa		x
Harrisonia abyssinica		x
Hymenaea verrucosa	not characteristic	x
Hyphaene compressa	secondary species (palm species)	f
Lecaniodiscus fraxinifolius		x
Manilkara sansibarensis	not characteristic	x
Manilkara sulcata	not characteristic	x
Markhamia obtusifolia		x
Milicia excelsa	not characteristic	x
Olea europaea	(*Olea europaea* ssp. *cuspidata* , synonym: *Olea africana*)	x
Sorindeia madagascariensis		x
Strychnos henningsii		x
Strychnos innocua		x
Syzygium cordatum		x
Syzygium guineense		x
Terminalia prunioides		x
Terminalia spinosa	indicator of disturbance	f
Vitex doniana		x
Vitex payos		x
Zanthoxylum chalybeum		x

15. Zanzibar-Inhambane scrub forest on coral rag (edaphic forest type, fc)

15.1. Description

White describes evergreen thickets that are the climax vegetation types on shallow soils that overlie coral limestone and that have rainfall between 950 and 1200 mm per year. We decided to equate this vegetation type with the "maritime eastern African coastal scrub forest" described by Clarke and Robertson (2000) who described these forests as scrub forests and thickets (with canopies of 6 - 10 m and occasional emergents of 8 - 15 m) that develop on shallow and easily dessicated soils that overly coral rag (*i.e.* surface limestone derived from recent corals). Both White (1983) and Clarke and Robertson (2000) refer to the same reference of Birch (1963) when describing this vegetation type.

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Zanzibar-Inhambane scrub forest on coral rag and no other Zanzibar-Inhambane forest types, include *Carpodiptera africana, Diospyros squarrosa, Grewia plagiophylla, Grewia truncata, Harrisonia abyssinica, Lannea schweinfurthii, Ludia mauritiana, Millettia usaramensis, Monanthotaxis fornicata, Pycnocoma littoralis, Sterculia rhynchocarpa, Tabernaemontana elegans, Uvaria leptocladon* and *Zanthoxylum chalybeum.*

15.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 15. Species composition of Zanzibar-Inhambane scrub forest on coral rag (fc)

SPECIES	Regional status	Coast
Carpodiptera africana	indicator species (evergreen thicket on coral limestone)	x
Diospyros squarrosa	indicator species (evergreen thicket on coral limestone)	f
Grewia plagiophylla	indicator species (evergreen thicket on coral limestone)	x
Grewia truncata	indicator species (evergreen thicket on coral limestone)	f
Harrisonia abyssinica	indicator species (evergreen thicket on coral limestone)	x
Lannea schweinfurthii	indicator species (evergreen thicket on coral limestone)	x
Ludia mauritiana	indicator species (evergreen thicket on coral limestone)	x
Millettia usaramensis	indicator species (evergreen thicket on coral limestone)	x
Monanthotaxis fornicata	indicator species (evergreen thicket on coral limestone)	f
Pycnocoma littoralis	indicator species (evergreen thicket on coral limestone)	f
Sterculia rhynchocarpa	indicator species (evergreen thicket on coral limestone)	f
Tabernaemontana elegans	indicator species (evergreen thicket on coral limestone)	x
Uvaria leptocladon	indicator species (evergreen thicket on coral limestone)	f
Zanthoxylum chalybeum	indicator species (evergreen thicket on coral limestone)	x
Manilkara sansibarensis	characteristic species (evergreen thicket on coral limestone)	x
Adansonia digitata		x
Afzelia quanzensis	not characteristic	x
Antiaris toxicaria	not characteristic	x
Bombax rhodognaphalon	not characteristic	x
Bridelia micrantha		x
Combretum schumannii	not characteristic	x
Dialium orientale		x
Dichrostachys cinerea		x
Diospyros mespiliformis	not characteristic	x
Dodonaea viscosa		x
Encephalartos hildebrandtii		x
Euclea racemosa	not characteristic	x
Euphorbia tirucalli		x
Ficus sur		x
Flacourtia indica		x
Flueggea virosa		x
Manilkara sulcata	not characteristic	x
Markhamia zanzibarica		x
Mimusops obtusifolia		x
Monodora grandidieri		x
Ozoroa insignis		x
Pandanus kirkii	genus occurs in Zanzibar-Inhambane swamp forest	x
Psydrax schimperiana		x
Pterocarpus angolensis		x
Ricinodendron heudelotii	not characteristic	x
Salvadora persica		x
Sclerocarya birrea		x
Sideroxylon inerme	not characteristic	x
Sorindeia madagascariensis		x
Sterculia africana		x
Syzygium cordatum		x
Tamarindus indica	not characteristic	x
Xylopia parviflora	not characteristic	x

16. Riverine forests (edaphic forest type, fr)

16.1. Description

Although White (1983) treated riverine forests separately within the descriptions of regional centres of endemism, we decided not to map floristic variants of riverine forests. Actually, it was in most situations not practical to map riverine forests.

Zambezian riparian forest can be further classified in: (i) evergreen or semi-evergreen riparian forest; and (ii) deciduous riparian forest. Evergreen or semi-evergreen riparian forest of 20 m (or taller) occurs on fringes or perennial streams in areas where annual rainfall exceeds 1000 mm. Riparian forest where most of the tree species are deciduous for at least two months are confined to the banks of major watercourses in areas where annual rainfall is less than 800 mm. The latter riparian forest type has probably always been kept open by movements and browsing of large mammals, which explains the presence of heliophilous ('sun-loving') species of *Acacia* and other genera (White 1983 p. 91). Evergreen riparian forests are among the associated vegetation types that characterize wetter miombo woodland (Wn), whereas deciduous riparian forests are among the associated vegetation types that characterize drier miombo woodland (White 1983 p. 93).

Sudanian riparian forest was further classified in: (i) semi-evergreen riparian forest; and (ii) semi-deciduous riparian forest. The former occurs in the southern (wetter) half of the Sudanian region, whereas the latter occurs in the northern (drier) half of the Sudanian region where it is often degraded to riparian woodland (White 1983 p. 105).

Somalia-Masai riparian forest occurs only on the banks of larger rivers such as the Galana, Kiboko, Tana, Uaso Nyiro and Voi rivers of Kenya (riparian forests also occur in Tanzania; White 1983 p. 117).

Since we think that the riverine occurrence of riverine forests is more characteristic than the species composition of these forests, we refer to section 20.3 for information about characteristic species.

16.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Figure 16.1. Riverine forest at Rusumo along Akagera River (Rwanda). Photograph by E. Fischer (October 1985).

Figure 16.2. Riverine forest dominated by *Cynometra* and *Baphia* species along the Mpanga River Gorge (Kamwenge, Uganda. Photograph by J. Kalema (January 2009).

Table 16. Species composition of Riverine forests (edaphic forest type, fr)

SPECIES	Regional status	Ethiopia	Kenya (forest subtype)	K enya (woodland subtype)	Malawi	Rwanda	Tanzania	Uganda	Zambia	Coast
Acacia asak		x								
Acacia elatior	Somalia-Masai riparian forest		C	C				f		C
Acacia galpinii	Zambezian deciduous riparian forest				C				f	
Acacia gerrardii		f	C		f	f	f	x	f	f
Acacia kirkii	Lake Victoria swamp forest		C			x	f	f	f	
Acacia nigrescens					f		f		C	
Acacia oerfota		f	x				f	C		f
Acacia polyacantha	Zambezian deciduous riparian forest	C	C		x	f	f	f	f	f
Acacia robusta	Somalia-Masai and Zambezian deciduous riparian forest	x	C	f			f		f	C
Acacia seyal		f	x	C	f		f	f	f	
Acacia sieberiana	Sudanian riparian forest	f	C		x	f	f	f	f	f
Acacia tortilis	Zambezian deciduous riparian forest, along larger seasonal streams in Marsabit district	f	C	C			f	C	f	f
Acacia xanthophloea	Zambezian deciduous riparian forest		C		x		f			f
Acokanthera oppositifolia			C		f				f	f
Afzelia quanzensis			f		x		f	f	f	C
Albizia glaberrima	Somalia-Masai riparian forest		C	f	x		C	f	x	f
Albizia grandibracteata		x	C			f	f	f		
Albizia petersiana			C		x	f	f	f		f
Albizia saman	(exotic species)		C							f
Albizia schimperiana		f	C		f		f	f	f	
Albizia versicolor	Zambezian deciduous riparian forest		f		x	f	f	f	f	x
Albizia zimmermannii	Somalia-Masai riparian forest		C	f	x		f		f	
Albizia zygia			C				f	f		
Allophylus abyssinicus		x	C		x	f	f	f	f	
Allophylus africanus		x	x		x	x	f	f	x	
Allophylus rubifolius		f	C		f	f	f	f	f	f
Annona senegalensis		f	C		x	f	f	f	f	f
Anthocleista grandiflora			C		x		f	f		C
Antiaris toxicaria		f	f			f	f	f	f	C
Antidesma venosum		x	C		f		f	f	x	C
Aphania senegalensis	riparian forest in the greater Serengeti region	C	C				f	f		C
Apodytes dimidiata	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	x	f		x	x	f	f	C	f
Baikiaea insignis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river (dominant)					x	f	f		
Balanites aegyptiaca		f	C			f	f	f	f	
Balanites wilsoniana			f				f	f		C
Berchemia discolor		x	C		x		f	f	f	f
Bersama abyssinica		x	C		f	x	f	f	f	f
Blighia unijugata		x	C		f	x	f	f	f	f
Bombax rhodognaphalon			f		x		f			C
Borassus aethiopum	(palm species)	f	C		D		f	f	f	f
Breonadia salicina	Sudanian and Zambezian evergreen or semi-evergreen riparian forest	C	x		C		f	f	C	C
Bridelia brideliifolia					x	x	x	x		
Bridelia micrantha		x	C		x	C	f	f	C	C
Burttdavya nyasica					C		f			C
Cadaba farinosa		f	C	C		f	f	f		f
Caesalpinia volkensii			C				f	f		f
Calodendrum capense			C		x		f	f		
Calotropis procera		x	C				f	f		f
Capparis tomentosa		x	C		x	f	f	x	x	f
Carissa spinarum		x	x		f	f	f	x	f	f
Celtis africana		C	C		f	f	f	f	f	x
Clausena anisata		f	C		x	x	f	f	x	f
Combretum imberbe	Zambezian deciduous riparian forest				x		f		f	f
Cordia africana		f	C		x	x	f	f	f	
Cordia monoica		x	C				f	f		f
Cordia sinensis		x	C	C			f	f	f	f
Cordyla africana	Zambezian deciduous riparian forest		f		C		f		f	f
Craibia brownii			C			f	f	f		f
Crateva adansonii		x	C				f	f		
Crotalaria agatiflora		f	C		f	f	f	f		
Croton macrostachyus		f	C		f	x	f	f	f	
Croton megalocarpus			C		f		f	f	f	
Cussonia spicata			C		f		f	f	f	
Delonix elata		f	f	C			f	C	f	
Diospyros abyssinica		x	C		f	f	f	f	f	x
Diospyros mespiliformis	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	C	C	f	C		C	f	C	C
Diospyros scabra		x	x	C				f		
Dobera glabra	Somalia-Masai riparian forest	f	x	f				f		f
Dombeya buettneri		f				x				
Dombeya kirkii		f	C		x	x	f	f	f	
Dovyalis abyssinica		x	C		f		f	f		
Dovyalis macrocalyx			C		x	x	f	f	f	f
Dracaena steudneri		f	f		x	x	f	f	f	
Ehretia cymosa		x	f		f	x		f		
Ekebergia capensis	riparian forest in the greater Serengeti region	f	C		x	x	f	f	x	f
Elaeodendron buchananii		f	C		x	f	f	f	f	
Embelia schimperi		x	f		x	x	f	f	x	
Ensete ventricosum		x	f		x	x	f	f	f	
Entada abyssinica		f	C		f	f	f	f	f	
Erythrina excelsa			C				f	f	f	

SPECIES	Regional status	Ethiopia	Kenya (forest subtype)	K enya (woodland subtype)	Malawi	Rwanda	Tanzania	Uganda	Zambia	Coast
Erythrophleum suaveolens	Zambezian evergreen or semi-evergreen riparian forest		f		C		f	f	C	C
Erythroxylum fischeri		x	C				f	f		
Euclea divinorum		f	C		x	f	f	f	x	f
Euclea natalensis			C		x		f		f	f
Euclea racemosa		f	f		x	x	f	C	f	f
Eugenia capensis		x	f		f	x	f	f	f	
Faidherbia albida	Zambezian deciduous riparian forest	f	C	C	x		f	x	C	f
Faurea saligna			f		x	f	f	f	C	f
Fernandoa magnifica	Somalia-Masai riparian forest (near coast and endemic to coastal forests)		f				x			f
Ficus exasperata		x	f		x	f	f	f	f	f
Ficus ingens	Somalia-Masai riparian forest	f	C	f	f	x	f	f	f	f
Ficus natalensis			C		f	f	f	f	f	f
Ficus ovata		x	C		f	f	f	f	f	
Ficus sur	Zambezian deciduous riparian forest	x	C		x	f	f	f	C	x
Ficus sycomorus	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	C	C	f	x	C	C	f	f	C
Ficus thonningii		x	C		f	x	f	f	f	
Ficus vallis-choudae		x	C		x	x	f	f	f	x
Ficus vasta		x	C				f	x	f	
Filicium decipiens		x	C		x		f			
Flacourtia indica		x	f		x	f	f	f	x	f
Flueggea virosa		f	C		f	f	f	f	f	f
Garcinia livingstonei	Somalia-Masai riparian forest (including greater Serengeti region)	x	C	f	x		f	f	C	C
Gardenia ternifolia		f	C			f	f	f		f
Gardenia volkensii		x	C				f	f	x	f
Grewia villosa		f	f	C			f	f		f
Harrisonia abyssinica		f	C		x	f	f	f	f	C
Hymenaea verrucosa			f				f			C
Hypericum quartinianum		f	C		f		f	f	f	
Hyphaene compressa	(palm species)	f	C	C			f			C
Hyphaene coriacea	(palm species)		f	C			f			f
Hyphaene petersiana	(palm species)				x		f		C	
Ilex mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river; Zambezian swamp forest	x	C		x	f	f	f	C	
Jatropha curcas			C		f		f	f	f	f
Justicia schimperiana		x	x				f			f
Khaya anthotheca	Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest		x	f	C		C	f	C	C
Kigelia africana	Somalia-Masai and Zambezian deciduous riparian forest	x	C	f	x	C	C	x	f	C
Kigelia moosa			C				f	f		
Landolphia buchananii		x	C		f		f	f	x	
Lannea schweinfurthii		f	x		x	f	f	f	f	f
Lawsonia inermis		f	C	x			f	f		C
Lecaniodiscus fraxinifolius	Somalia-Masai (including greater Serengeti region) and Zambezian deciduous riparian forest	x	C	f	x		f	f	f	C
Leptadenia hastata		f	C							
Maerua decumbens		f	C				f	f		f
Maesa lanceolata		x	f		x	x	f	f	x	
Maesopsis eminii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		C		f	f	f	f	f	
Manilkara mochisia	Zambezian deciduous riparian forest		f		x		f		C	f
Markhamia lutea			C			x	f	f		
Maytenus arbutifolia		f	C			f	f	f		
Maytenus senegalensis		f	C		f	f	f	f	x	f
Milicia excelsa		f	f		C	f	f	f		C
Mimusops bagshawei			C			x	f	f		f
Mimusops kummel		C	C		f		f	f		
Mimusops obtusifolia			f		x		f			C
Mimusops zeyheri	Zambezian deciduous riparian forest				f		f		C	
Monodora myristica			C				f	f		
Monopetalanthus richardsiae	Zambezian evergreen or semi-evergreen riparian forest						f		x	
Moringa stenopetala		f	f					C		
Mussaenda arcuata		x	f				f	f		
Myrianthus holstii			C		f	f	f	f	f	f
Newtonia buchananii	Zambezian evergreen or semi-evergreen riparian forest; near streams in Afromontane dry transitional forest		C		C	x	f	f	f	C
Newtonia hildebrandtii	Somalia-Masai and Zambezian deciduous riparian forest		C	f	x		f		f	
Oncoba spinosa		x	C		x		f	f	x	
Oreobambos buchwaldii	(bamboo species indigenous to Africa)		C		x		f	f	f	
Oxystigma msoo			C				f			x
Parinari excelsa					x	f	f	f	C	C
Parkia filicoidea	Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest (Lake Victoria swamp forest)		x	f	C		C	f	f	C
Parkinsonia aculeata			C							
Pavetta oliveriana		x	C			x	f	f		
Phoenix dactylifera			x				f			f
Phoenix reclinata	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest; palm species	C	C		x	x	f	f	x	C
Phytolacca dodecandra		f	C		f	x	f	f	f	
Piliostigma thonningii		f	f		x	f	f	f	f	C
Pittosporum viridiflorum		f	C		x	x	f	f	f	
Polyscias fulva			C		f	f	f	f	f	
Populus ilicifolia	Somalia-Masai riparian forest		C	f			f			C
Premna schimperi		x					f	f		
Prunus africana		f	C		x	f	f	f	f	

SPECIES	Regional status	Ethiopia	Kenya (forest subtype)	K enya (woodland subtype)	Malawi	Rwanda	Tanzania	Uganda	Zambia	Coast
Acacia asak		x								
Acacia elatior	Somalia-Masai riparian forest		C	C				f		C
Acacia galpinii	Zambezian deciduous riparian forest				C				f	
Acacia gerrardii		f	C		f	f	f	x	f	f
Acacia kirkii	Lake Victoria swamp forest		C			x	f	f	f	
Acacia nigrescens					f		f		C	
Acacia oerfota		f	x				f	C		f
Acacia polyacantha	Zambezian deciduous riparian forest	C	C		x	f	f	f	f	f
Acacia robusta	Somalia-Masai and Zambezian deciduous riparian forest	x	C	f			f		f	C
Acacia seyal		f	x	C	f		f	f	f	
Acacia sieberiana	Sudanian riparian forest	f	C		x	f	f	f	f	f
Acacia tortilis	Zambezian deciduous riparian forest, along larger seasonal streams in Marsabit district	f	C	C			f	C	f	f
Acacia xanthophloea	Zambezian deciduous riparian forest		C		x		f			f
Acokanthera oppositifolia			C		f				f	f
Afzelia quanzensis			f		x		f	f	f	C
Albizia glaberrima	Somalia-Masai riparian forest		C	f	x		C	f	x	f
Albizia grandibracteata		x	C			f	f	f		
Albizia petersiana			C		x	f	f	f		f
Albizia saman	(exotic species)		C							f
Albizia schimperiana		f	C		f		f	f	f	
Albizia versicolor	Zambezian deciduous riparian forest		f		x	f	f	f	f	x
Albizia zimmermannii	Somalia-Masai riparian forest		C	f	x		f		f	
Albizia zygia			C				f	f		
Allophylus abyssinicus		x	C		x	f	f	f	f	
Allophylus africanus		x	x		x	x	f	f	x	
Allophylus rubifolius		f	C		f	f	f	f	f	f
Annona senegalensis		f	C		x	f	f	f	f	f
Anthocleista grandiflora			C		x		f	f		C
Antiaris toxicaria		f	f			f	f	f	f	C
Antidesma venosum		x	C		f		f	f	x	C
Aphania senegalensis	riparian forest in the greater Serengeti region	C	C				f	f		C
Apodytes dimidiata	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	x	f		x	x	f	f	C	f
Baikiaea insignis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river (dominant)					x	f	f		
Balanites aegyptiaca		f	C			f	f	f	f	
Balanites wilsoniana			f				f	f		C
Berchemia discolor		x	C		x		f	f	f	f
Bersama abyssinica		x	C		f	x	f	f	f	f
Blighia unijugata		x	C		f	x	f	f	f	f
Bombax rhodognaphalon			f		x		f			C
Borassus aethiopum	(palm species)	f	C		D		f	f	f	f
Breonadia salicina	Sudanian and Zambezian evergreen or semi-evergreen riparian forest	C	x		C		f	f	C	C
Bridelia brideliifolia					x	x	x	x		
Bridelia micrantha		x	C		x	C	f	f	C	C
Burttdavya nyasica					C		f			C
Cadaba farinosa		f	C	C		f	f	f		f
Caesalpinia volkensii			C				f	f		f
Calodendrum capense			C		x		f	f		
Calotropis procera		x	C				f	f		f
Capparis tomentosa		x	C		x	f	f	x	x	f
Carissa spinarum		x	x		f	f	f	x	f	f
Celtis africana		C	C		f	f	f	f	f	x
Clausena anisata		f	C		x	x	f	f	x	f
Combretum imberbe	Zambezian deciduous riparian forest				x		f		f	f
Cordia africana		f	C		x	x	f	f	f	
Cordia monoica		x	C				f	f		f
Cordia sinensis		x	C	C			f	f	f	f
Cordyla africana	Zambezian deciduous riparian forest		f		C		f		f	f
Craibia brownii			C			f	f	f		f
Crateva adansonii		x	C				f	f		
Crotalaria agatiflora		f	C		f	f	f	f		
Croton macrostachyus		f	C		f	x	f	f	f	
Croton megalocarpus			C		f		f	f	f	
Cussonia spicata			C		f		f	f	f	
Delonix elata		f	f	C			f	C	f	
Diospyros abyssinica		x	C		f	f	f	f	f	x
Diospyros mespiliformis	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	C	C	f	C		C	f	C	C
Diospyros scabra		x	x	C				f		
Dobera glabra	Somalia-Masai riparian forest	f	x	f				f		f
Dombeya buettneri		f				x				
Dombeya kirkii		f	C		x	x	f	f	f	
Dovyalis abyssinica		x	C		f		f	f		
Dovyalis macrocalyx			C		x	x	f	f	f	f
Dracaena steudneri		f	f		x	x	f	f	f	
Ehretia cymosa		x	f		f	x		f		
Ekebergia capensis	riparian forest in the greater Serengeti region	f	C		x	x	f	f	x	f
Elaeodendron buchananii		f	C		x	f	f	f	f	
Embelia schimperi		x	f		x	x	f	f	x	
Ensete ventricosum		x	f		x	x	f	f	f	
Entada abyssinica		f	C		f	f	f	f	f	
Erythrina excelsa			C				f	f	f	

17. Swamp forest (edaphic forest type, fs)

17.1. Description

In analogy with riverine forests (fr), we decided not to map floristic variants of riverine forests although White (1983) treated riverine forests separately within the descriptions of regional centres of endemism. Actually, it was in most situations not practical to map swamp forests.

In the wetter parts of the Zambezian region (with rainfall above 1000 mm), permanent swamp forest occurs around springs at the sources of tributary streams. Swamp forests also occurs along watercourses (*i.e.* also as subtype of riverine forest [fr]) where water movement is locally sluggish. In the latter situation, swamp forests merge into other types of riparian forest in which the water table is at some distance below the surface for at least part of the year (White 1983 p. 91).

Although White (1983) lists a heading within the description of the Sudanian region as "Sudanian swamp forest and riparian forest", he does not give a specific description of Sudanian swamp forest (White 1983 pp. 103 - 104).

Swamp forests dominated by species that are widespread in tropical Africa occur extensively on the shores of Lake Victoria and elsewhere in the Lake Victoria region. On alluvial deposits of the Kagera river (on the western shore of Lake Victoria), a unique swamp forest occurs that is composed almost in equal proportions of lowland (especially Guineo-Congolian) and Afromontane species and that is dominated by *Baikiaea insignis* (a Guineo-Congolian species) and by *Podocarpus usambarensis* var. *dawei* (an Afromontane species; White 1983 p. 181).

Fresh-water swamp forest is of restricted occurrence in the Zanzibar-Inhambane region. *Barringtonia racemosa*, a species associated with mangroves (M), often occurs in swamp forests immediately behind the mangrove zone and extends upstream for considerable distances (White 1983 p. 188).

17.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 17. Species composition of Swamp forest (edaphic forest type, fs)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda (fsbU subtype)	Uganda (fsrU subtype)	Zambia	Coast
Acacia kirkii	Lake Victoria swamp forest		f		f	f	f	C	f	
Acrostichum aureum	Zanzibari-Inhambane swamp forest (fern species)					f				x
Albizia glaberrima	Somalia-Masai riparian forest		f	f		f	x	f	f	f
Alchornea hirtella			f	f	f	f	x	f	x	
Anthocleista grandiflora			C	x		f	f	f		x
Anthocleista schweinfurthii	Lake Victoria swamp forest	f			f	f	x	f	C	
Antidesma venosum		C	f	f		f	f	f	f	f
Apodytes dimidiata	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	x	f	f	f
Aporrhiza nitida	Zambezian swamp forest			f					x	
Baikiaea insignis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river (dominant)				f	f	D	f		
Barringtonia racemosa	Zanzibar-Inhambane swamp forest, also mangrove associated species		f			f				x
Beilschmiedia ugandensis			f			f	x	f	C	
Blighia unijugata		f	f	f	C	f	x	C	f	f
Bridelia micrantha		f	f	f	f	f	x	f	x	f
Canarium schweinfurthii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river	f				f	x	f	f	
Celtis africana		f		f	C	f	f	f	f	f
Celtis gomphophylla		f	f	f	f	C	f	C	f	f
Clausena anisata		f	f	f	f	f	x	f	x	f
Combretum imberbe	Zambezian deciduous riparian forest			f		f			f	f
Cordia africana		f	f	f	C	f	x	f	f	
Cordyla africana	Zambezian deciduous riparian forest		C			C			f	f
Craterispermum laurinum	Zambezian swamp forest		f						x	
Croton megalocarpus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	f	f	x	f	f	
Diospyros mespiliformis	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	f	C	f		f	f	f	f	f
Dombeya rotundifolia		f	f	f	C		f	f	f	
Dracaena camerooniana	Zambezian swamp forest								x	
Ekebergia capensis	riparian forest in the greater Serengeti region	f	f	f	C	f	x	f	x	f
Elaeis guineensis	Zanzibar-Inhambane swamp forest (palm species)		f	f		f	f	f		x
Erythrina abyssinica		f	f	f	x	f	x	f	f	f
Erythrina excelsa	Lake Victoria swamp forest		f			f	x	f	f	
Erythrophleum suaveolens	Zambezian evergreen or semi-evergreen riparian forest		f	f		C	f	f	f	f
Erythroxylum fischeri			C			f	x	f		
Euclea divinorum		f	f	f	C	f	f	f	f	f
Faidherbia albida		f	C	f	f	f	f	f	f	f
Ficalhoa laurifolia				f	f	f	f	f	C	
Ficus natalensis			C	f	f	f	x	f	f	f
Ficus sur	Zambezian deciduous riparian forest	f	C	f	f	f	x	f	C	x
Ficus sycomorus	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	f	x	f	x	f	x	f	f	x
Ficus trichopoda	Lake Victoria swamp forest; Zambezian swamp forest			x	C	f	f	f	C	
Ficus vallis-choudae		f	f	f	C	f	f	f	f	f
Flueggea virosa		f	f	f	f	f	x	x	f	f
Funtumia africana			C	f		f	x	f		f
Garcinia smeathmannii	Zambezian swamp forest			f		f			x	
Gardenia imperialis	Zambezian swamp forest			f		f	f	f	x	
Hallea stipulosa	Lake Victoria swamp forest; Zambezian swamp forest			x		x	f	f	C	
Hibiscus tiliaceus	Zanzibar-Inhambane swamp forest, also mangrove associated species		x			f				x
Ilex mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river; Zambezian swamp forest	f	f	f	f	f	C	f	C	
Khaya anthotheca	Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest		f	f		C	f	f	f	f
Kigelia africana	Somalia-Masai and Zambezian deciduous riparian forest		f	f	f	f	x	C	f	f
Klainedoxa gabonensis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river					f	x	f	f	
Lannea schweinfurthii			f	f	C	f	f	f	f	f
Lecaniodiscus fraxinifolius	Somalia-Masai (including greater Serengeti region) and Zambezian deciduous riparian forest		f	f		f	x	f	f	f
Macaranga monandra	Lake Victoria swamp forest					f	x	f		
Macaranga schweinfurthii	Lake Victoria swamp forest		C		x	f	x	f	f	
Macaranga spinosa	Lake Victoria swamp forest					C				
Maesa lanceolata		f	f	f	f	f	x	f	x	
Maesopsis eminii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		f		f	f	x	f	f	
Musanga cecropioides	Lake Victoria swamp forest					x	f	f		
Newtonia buchananii	Zambezian evergreen or semi-evergreen riparian forest; near streams in Afromontane dry transitional forest		C	f	f	f	f	f	f	f
Parinari excelsa				f	f	f	x	f	C	f

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda (fsbU subtype)	Uganda (fsrU subtype)	Zambia	Coast
Parkia filicoidea	Lake Victoria swamp forest (also Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest)		C	f		f	x	f	f	f
Peddiea fischeri			f		f	f	x	f	x	
Phoenix reclinata	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest; palm species	C	f	x	f	f	f	C	x	x
Podocarpus falcatus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	f	f		
Podocarpus latifolius	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	x	f	D	f	f	
Podocarpus usambarensis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river (dominant [*Podocarpus usambarensis* var. *dawei*])		f			f	D	f		
Pseudospondias microcarpa	Lake Victoria swamp forest; Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		C		f	f	x	f	f	
Psychotria mahonii			C	f	f	f	x	f	f	
Psychotria peduncularis	Zambezian swamp forest		f	f	x	f	f	f	x	
Pterocarpus tinctorius				f		C			f	f
Pycnanthus angolensis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river					f	x	f	f	
Raphia farinifera	Lake Victoria swamp forest (palm species)		C	x		f	x	f	C	x
Rauvolfia caffra			f	f		f	x	D	C	f
Ritchiea albersii		f	f		C	f	x	f	f	
Rothmannia urcelliformis		f	f	f		f	x	x	f	
Schrebera arborea							x	C		
Scutia myrtina		f	f	f	C	f	x	f	x	
Shirakiopsis elliptica		f	f	f	C	f	x	f	C	
Sorindeia madagascariensis			C	f		f				x
Spondianthus preussii	Lake Victoria swamp forest					f	C	f		
Sterculia tragacantha					f	f			C	
Strombosia scheffleri	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	f	f	x	f		f
Strychnos mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f		f	x	f		f
Symphonia globulifera	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river				f	f	x	f	f	
Syzygium cordatum	Lake Victoria swamp forest; Zambezian swamp forest		f	D	C	f	f	x	C	f
Syzygium guineense	Sudanian riparian forest (*Syzygium guineense* ssp. *guineense*)	C	f	f	x	f	x	f	f	f
Syzygium owariense	Zambezian swamp forest			D		f	f	f	C	
Terminalia sambesiaca	Somalia-Masai riparian forest		f	f		C			f	f
Tetrapleura tetraptera	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		f				x	f		f
Trichocladus ellipticus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	x	f	f	
Typhonodorum lindleyanum	Zanzibar-Inhambane swamp forest					f				x
Uapaca guineensis	Lake Victoria swamp forest; Zambezian swamp forest			f		f			C	f
Vangueria madagascariensis		f	C	f		f	f	f		f
Vepris nobilis		f	f	f	C	f	x	f	f	f
Vitex doniana	Sudanian riparian forest	f	f	f	f	f	f	f	f	x
Voacanga thouarsii	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest		C	f		x	f	f	x	x
Warburgia ugandensis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f		f	x	f		
Xylopia aethiopica	Zambezian swamp forest		f			f	x	f	C	f
Xylopia rubescens	Zambezian swamp forest					f	f	f	C	
Ziziphus pubescens		f	C	f		f	f	f	f	f

18. *Combretum* wooded grassland (Wc)

18.1. Description

Trapnell and Langdale-Brown (1972 p. 133) describing *Combretum* wooded grasslands of Kenya, Tanzania and Uganda mention that various broad-leaved *Combretum* species (the most general species being *Combretum adenogonium* [synonym: *Combretum ghasalense*], *Combretum collinum* [synonym: *Combretum binderianum*], *Combretum molle* and *Combretum zeyheri*) are associated with larger-leaved species of *Terminalia* (another species of the Combretaceae botanical family)[5] in wetter areas - especially *Terminalia glaucescens* and *Terminalia mollis*. In drier areas, *Combretum* species are associated with smaller-leaved *Terminalia* species: *Terminalia brownii* in Kenya and Uganda and *Terminalia sericea* in the "monsoon sector" of Tanzania (*i.e.* areas with a one-season summer rainy season typically occupied by miombo woodland [Wm]). These authors further mentioned that *Combretum* wooded grasslands is the major East African wooded grassland vegetation type.

White (1983) does not refer to *Combretum* or *Combretum-Terminalia* vegetation in the main descriptions of the Zambezian, Somalia-Masai, Sudanian, Afromontane, Lake Victoria or Zanzibar-Inhambane regional centres of endemism.[6] However, in the description of the greater Serengeti region, White (1983) describes *Combretum-Terminalia* secondary wooded grassland as a vegetation type with an open overstorey that is dominated by *Combretum molle* (10 - 13 m) and *Terminalia mollis* (15 -17 m). This vegetation type is a fire climax community that has replaced dry evergreen forest on ridges tops and upper slopes in the northern part of the Serengeti national park (White 1983 p. 121). *Combretum molle* woodland is probably a fire-induced vegetation type that has replaced evergreen bushland (Be) or scrub forest on wetter upland areas of Marsabit district (White 1983 p. 121). "Ethiopian undifferentiated woodland" as described by White (1983 p. 107) is virtually equivalent to *Combretum-Terminalia* woodland and wooded grassland described in the atlas of potential natural vegetation types of Ethiopia (Friis *et al.* 2010 p. 170).

18.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

5: Lind and Morrison (1974 p. 90) use the name of "Combretaceous wooded grassland and woodland" because the common occurrence of Combretum and Terminalia. Terminalia is similar in appearance to Combretum, but Terminalia can be recognized from its two-winged woody fruits whereas Combretum is characterized by four-winged woody fruits. These authors (p. 81) make the distinction between woodland and wooded grassland vegetation types with predominantly compound-leaved trees (miombo woodland and Acacia woodland) and vegetation with predominantly simple-leaved trees (Combretaceous woodland and wooded grassland, Vitellaria woodland and wooded grassland and Borassus palm grassland

6: This is probably because in many cases, these vegetation types are transitional or secondary (J. Timberlake, pers. comm.)

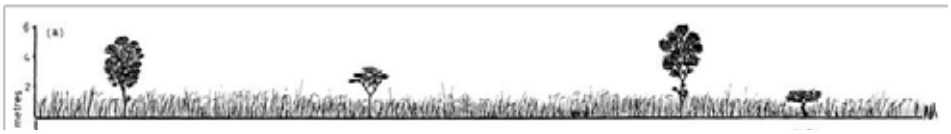

Figure 18.1. This type of *Combretum* wooded grassland vegetation was originally described as "tall *Hyparrhenia* – *Combretum* wooded grassland". Note that *Hyparrhenia* is a genus of grass species. Pratt *et al.* (1966, Fig 5a). Image obtained from URL: http://www.jstor.org/stable/2401259.

Figure 18.2. *Combretum – Terminalia* woodland and wooded grassland on stony soil derived from the basement complex at the foothills of the western escarpment near Bumbadi (Ethiopia). The palm species *Hyphaene thebaica* can be seen in the foreground. Altitude approximately 750 m. Photograph by I. Friis and Sebsebe Demissew (October 2008). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 18A. 2010.

Figure 18.3. *Combretum – Terminalia* woodland and wooded grassland with tall underground of grasses (mainly *Hyparrhenia* species) on rocky outcrops east of Kurmuk (Ethiopia). Altitude approximately 1100 m. Photograph by I. Friis and Sebsebe Demissew (October 1998). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 18B. 2010.

Table 18. Species composition for *Combretum* wooded grassland (Wc)

SPECIES	Regional status	Ethiopia	dry Combretum (Kenya)	dry Combretum (Uganda)	moist Combretum (Kenya)	moist Combretum (Uganda)	WacU (Uganda subtype)
Acacia hockii	characteristic species for Sudanian undifferentiated woodland	C	x	C	x	f	x
Acacia nilotica	characteristic species for Sudanian undifferentiated woodland	f	x	x			
Acacia polyacantha	characteristic species for Sudanian undifferentiated woodland	x	x	x	x	x	x
Acacia senegal	characteristic species for Sudanian undifferentiated woodland	x	x	x			
Acacia seyal	characteristic species for Sudanian undifferentiated woodland	x	x	C	x	f	
Acacia sieberiana	characteristic species for Sudanian undifferentiated woodland	x	f	x	x	f	x
Annona senegalensis	characteristic species for Sudanian undifferentiated woodland	x	x	C	C	x	x
Anogeissus leiocarpa	characteristic species for Ethiopian undifferentiated woodland and for Sudanian undifferentiated woodland	C					
Balanites aegyptiaca	characteristic species for Ethiopian undifferentiated woodland and for Sudanian undifferentiated woodland	C	x	C	x	f	
Boscia salicifolia	characteristic species for Sudanian undifferentiated woodland	f	x	x			
Boswellia papyrifera	characteristic species for Ethiopian undifferentiated woodland	C	f	C			
Combretum adenogonium	characteristic species for Sudanian undifferentiated woodland	C	x	C	C	f	
Combretum collinum	characteristic species for Ethiopian undifferentiated woodland and for Sudanian undifferentiated woodland	C	C	C	C	x	C
Combretum hartmannianum	characteristic species for Ethiopian undifferentiated woodland	C					
Combretum molle	characteristic species for Sudanian undifferentiated woodland	C	C	C	C	C	C
Commiphora africana	characteristic species for Ethiopian undifferentiated woodland and for Sudanian undifferentiated woodland	f	x	C			
Crossopteryx febrifuga	characteristic species for Sudanian undifferentiated woodland	x	f	f			
Cussonia arborea	characteristic species for Sudanian undifferentiated woodland	x	x	x	x	f	
Dalbergia melanoxylon	characteristic species for Ethiopian undifferentiated woodland and for Sudanian undifferentiated woodland	C	x	C			
Dichrostachys cinerea	characteristic species for Sudanian undifferentiated woodland	x	x	f	x	f	
Diospyros mespiliformis	characteristic species for Sudanian undifferentiated woodland	x	x	f			
Ekebergia capensis	characteristic species for Sudanian undifferentiated woodland	f	f	x		f	
Erythrina abyssinica	characteristic species for Ethiopian undifferentiated woodland	x	x	x	x	x	x
Faurea saligna	characteristic species for Sudanian undifferentiated woodland		C	f	x	f	
Ficus glumosa	characteristic species for Sudanian undifferentiated woodland	x	x	f	x	f	
Ficus sycomorus	characteristic species for Sudanian undifferentiated woodland	f	x	f	x	f	
Gardenia ternifolia	characteristic species for Ethiopian undifferentiated woodland	x	x	x	x	f	
Lannea humilis	characteristic species for Sudanian undifferentiated woodland	f	f	C			
Lannea schimperi	characteristic species for Ethiopian undifferentiated woodland and for Sudanian undifferentiated woodland	x	x	C	x	f	
Parinari curatellifolia	characteristic species for Sudanian undifferentiated woodland		x	f	C	f	
Philenoptera laxiflora	characteristic species for Ethiopian undifferentiated woodland and for Sudanian undifferentiated woodland	C		C			
Piliostigma thonningii	characteristic species for Ethiopian undifferentiated woodland and for Sudanian undifferentiated woodland	C	x	C	C	x	
Pseudocedrela kotschyi	characteristic (Sudanian woodland and Guineo-Congolian secondary wooded grassland)	x		C			
Sclerocarya birrea	characteristic species for Sudanian undifferentiated woodland	C	x	C			
Steganotaenia araliacea	characteristic species for Sudanian undifferentiated woodland	x	x	x	x	f	
Stereospermum kunthianum	characteristic species for Ethiopian undifferentiated woodland and for Sudanian undifferentiated woodland	C	x	C	x	x	
Syzygium guineense	characteristic species for Sudanian woodland [*Syzygium guineense* ssp. *guineense*])	x	f	x	x	f	
Tamarindus indica	characteristic species for Sudanian undifferentiated woodland	f	x	x	x	x	
Terminalia brownii	characteristic species for Ethiopian undifferentiated woodland	C	C	C	x	f	
Terminalia laxiflora	characteristic species for Sudanian undifferentiated woodland	C		f			
Terminalia schimperiana	characteristic species for Sudanian undifferentiated woodland	f		C		C	x
Trichilia emetica	characteristic species for Sudanian undifferentiated woodland	f	x	f	x	f	
Vitellaria paradoxa	characteristic species for Sudanian undifferentiated woodland and Sudanian secondary grassland	x		x			
Vitex doniana	characteristic species for Sudanian undifferentiated woodland	C	f	f	C	f	
Ziziphus abyssinica	characteristic species for Sudanian undifferentiated woodland	x	x	C	x	f	
Ziziphus mauritiana	characteristic species for Sudanian undifferentiated woodland	f	x	f			
Ziziphus mucronata	characteristic species for Sudanian undifferentiated woodland	x	x	f	x	f	
Acacia brevispica		f	x	f	x	f	
Acacia drepanolobium		x	x	f	x	f	
Acacia gerrardii	not characteristic	x	x	x	x	f	
Acacia tortilis		x	x	f			
Acokanthera oppositifolia			x		x		
Acokanthera schimperi		f	x	f	x	f	
Adansonia digitata		C	x				
Albizia anthelmintica		x	x	C			
Albizia coriaria		x	f	C	x	x	x
Albizia malacophylla		x		x			
Albizia zygia			f	C	x	C	C
Allophylus africanus		x	f	f	x	f	
Allophylus rubifolius		x	x	f	x		
Antidesma venosum		f	x	f	x	f	
Apodytes dimidiata		f	x	f	x	f	

SPECIES	Regional status	Ethiopia	dry Combretum (Kenya)	dry Combretum (Uganda)	moist Combretum (Kenya)	moist Combretum (Uganda)	WacU (Uganda subtype)
Borassus aethiopum		x	f	f	x	f	
Bridelia micrantha		f	x	f	x	f	
Bridelia scleroneura		x	x	C	x	x	x
Calotropis procera		f	x	f	x	f	
Capparis tomentosa		f	x	f	x	f	
Carissa spinarum		f	x	f	x	f	
Catha edulis		f	x	f	x	f	
Clausena anisata		f	x	f	x	f	
Clerodendrum myricoides		x	x	f	x	f	
Combretum aculeatum	(Combretaceae)	f	x	f			
Combretum schumannii	(Combretaceae)		x				
Combretum zeyheri	(Combretaceae)		C		x		
Commiphora habessinica		f	x	x			
Cordia africana		x	x	f			
Cordia monoica		f	x	f	x	f	
Croton macrostachyus		x	x	x	x	f	
Cussonia holstii		f	x	f	x	f	
Dodonaea viscosa		f	x	f	x	f	
Dombeya buettneri		x					
Dombeya rotundifolia		f	x	C	x	f	
Elaeodendron buchananii		f	x	f	x	f	
Entada abyssinica		x	f	x	x	f	
Erythrina burttii			x				
Euclea divinorum		f	x	f	x	f	
Euclea racemosa		f	x	x	C	f	
Euphorbia candelabrum		x	x	f	x	f	
Euphorbia tirucalli		f	x	f	x	f	
Faurea rochetiana		x	f	f	C	f	
Ficus natalensis			x	f	x	f	
Flacourtia indica		f	x	f	x	f	
Flueggea virosa		x	x	f	x	f	
Gardenia volkensii		x	x	f	x	f	
Grewia bicolor		x	x	f	x	f	
Grewia mollis		x	x	f	x	f	
Grewia similis		f	x	f	x	f	
Grewia tembensis		f	x		x		
Grewia villosa		f	x	f	x	f	
Harrisonia abyssinica		x	x	C	x	f	
Indigofera swaziensis			x	f	x	f	
Jatropha curcas			x	f	x	f	
Kigelia africana		f	x	x	x	f	
Lannea barteri		C		x			C
Lannea fulva					x	f	
Lannea schweinfurthii		x	x	f	x	f	
Lannea triphylla		f	x	C			
Lecaniodiscus fraxinifolius		f	x	f	x	f	
Lippia kituiensis			x		x		
Maerua decumbens		f	x	f	x	f	
Markhamia lutea					x	x	
Maytenus arbutifolia		f	x	f	x	f	
Maytenus senegalensis	not characteristic	x	x	C	C	f	
Maytenus undata		f	x	f	x	f	
Meyna tetraphylla		x	x	f			
Milicia excelsa		f	x	f	x	x	
Mussaenda arcuata					x	f	
Oncoba spinosa		x	x	f	x	f	
Ormocarpum kirkii			x				
Ormocarpum trichocarpum		f	x	x	x	f	
Oxytenanthera abyssinica	(lowland bamboo species)	C		C			
Ozoroa insignis		x	x	C	x	x	
Pappea capensis		x	x	x	x	f	
Pavetta crassipes		x	x	x	x	f	
Pavetta oliveriana		x	f	f	x	f	
Phytolacca dodecandra		f	x	f	x	f	
Pittosporum viridiflorum		f	x	f	x	f	
Plectranthus barbatus		f	x	f	x	f	
Premna resinosa		f	x	f	x	f	
Psydrax schimperiana		x	x	f	x	f	
Pterolobium stellatum		f	x	f	x	f	
Rauvolfia caffra			x	f	x	f	
Rhamnus staddo		f	x	f	x	f	
Rhoicissus revoilii		x	x	f	x	f	
Rhoicissus tridentata		x	x	f	x	f	

SPECIES	Regional status	Ethiopia	dry Combretum (Kenya)	dry Combretum (Uganda)	moist Combretum (Kenya)	moist Combretum (Uganda)	WacU (Uganda subtype)
Rhus longipes		x	x	f	x	f	
Rhus natalensis		x	x	C	x	f	
Rhus tenuinervis		x	x				
Rhus vulgaris		x	x	f	x	f	
Rubus volkensii		f	x	f	x	f	
Salvadora persica		f	x	f	x	f	
Sarcocephalus latifolius	not characteristic	x	f	f	x	f	
Scutia myrtina		f	x	f	x	f	
Securidaca longipedunculata	not characteristic	x	x	x	x	f	
Senna didymobotrya		f	x	f	x	f	
Senna septemtrionalis			x	f	x	f	
Senna singueana		f	x	x	x	f	
Sterculia africana		x	x				
Strychnos henningsii		x	x	f	x	f	
Strychnos innocua	not characteristic	x	f	C			x
Strychnos spinosa	not characteristic	x	x	f	x	f	
Tarenna graveolens		f	x	f	x	f	
Tephrosia vogelii			x	f	x	f	
Terminalia mollis	(Combretaceae)		x	x	C	f	
Terminalia prunioides	(Combretaceae)	f	x				
Terminalia spinosa	(Combretaceae)	f	x	C			
Tetradenia riparia		f	x		x		
Vangueria apiculata		f	x	f	x	f	
Vangueria infausta			x	f	x	f	
Vangueria madagascariensis		f	x	f	x	f	
Vepris nobilis		f	x	f	x	f	
Warburgia ugandensis		f	x	f	x	f	
Ximenia americana		x	x	x	x	f	
Zanthoxylum chalybeum		f	x	f	x	f	
Zanthoxylum usambarense		f	x		x		
Ziziphus pubescens		f	x	f	x	f	

19. *Acacia-Commiphora* deciduous wooded grassland (synonym: deciduous wooded grassland, Wd)

19.1. Description

Throughout volumes 2 to 5, we use "deciduous wooded grassland (Wd)" as a synonym of "*Acacia-Commiphora* deciduous wooded grassland (Wd)".

Although grasses are inconspicuous in typical Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd), *Acacia-Commiphora* deciduous wooded grassland communities exist such as the wooded grasslands from the greater Serengeti region (Tanzania). The wooded grasslands from the greater Serengeti region are different from typical deciduous bushland communities (Bd) by the insignificance of bushy plants other than *Acacia* and *Commiphora* and by the relative abundance of grasses (especially perennial grass species). The extent to which these features might be a result from prevalent grass fires or a large ungulate population is uncertain, but rainfall is too high in most places of the greater Serengeti region for typical deciduous bushland to occur (except along the drier eastern fringe; White 1983 pp. 125 and 128).

Somalia-Masai deciduous wooded grassland is the most extensive woody vegetation type (88 percent) in the Serengeti National Park. It consists of a single open stratum of *Acacia* or *Commiphora* thorn trees mostly 3 to 7 m high, but 9 to 20 m in a few species. This vegetation is wooded grassland since canopy cover is less than 40 percent in most places. The grass stratum is 0.5 to 1.5 m high and is dominated by *Digitaria macroblephara*, *Eustachys paspaloides*, *Pennisetum mezianum* (on poorly drained soils) and *Themeda triandra*. The wooded grasslands of the greater Serengeti region can be mapped by one mapping unit that is dominated by *Commiphora schimperi* and 38 mapping units that contain one or several of 11 *Acacia* species (including *Acacia drepanolobium, Acacia gerrardii, Acacia hockii, Acacia nilotica, Acacia robusta, Acacia senegal, Acacia seyal, Acacia sieberiana, Acacia tortilis, Acacia polyacantha* and *Acacia xanthophloea*; White 1983 p. 126). Several of these species are also characteristic of biotic *Acacia* wooded grassland [We; especially *Acacia gerrardii* and *Acacia hockii*], Somalia-Masai edaphic grassland [we; especially *Acacia drepanolobium* and *Acacia xanthophloea*]), riparian communities (wr; especially *Acacia xanthophloea*) or Undifferentiated woodland (Wn; especially *Acacia polyacantha* and *Acacia sieberiana*; within the greater Serengeti region these species occur as riparian species).Rather than attempting to subdivide these wooded grasslands, we classified all woody grasslands within the Somalia-Masai region and Tanzania as "*Acacia-Commiphora* deciduous wooded grassland (Wd)" except where vegetation modelling suggested that evergreen bushland (Be) could occur (we mapped these specific areas as biotic *Acacia* wooded grassland [We]; see Volume 6). **We thus think that it is**

probable that the areas of biotic *Acacia* wooded grassland (We) and Somalia-Masai edaphic grassland (we) are underestimated in Tanzania. It is also likely that vegetation types similar to Undifferentiated Woodland (Wn) and that can possibly be classified as *Combretum* wooded grassland (Wc) cross the floristic boundary between the Zambezian and Somalia-Masai regions; this seems especially a possible scenario in the southern part of the area that we mapped as *Acacia-Commiphora* deciduous wooded grassland (Wd).

Figure 19.1. *Acacia tortilis* woodland in Isiolo District (Kenya) was classified in VECEA as subtype WdK. Since this vegetation type does not occur near (seasonal) rivers, it was not classified as riverine vegetation. Photograph by F. Gachathi (2008).

19.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 19. Species composition for *Acacia-Commiphora* deciduous wooded grassland (synonym: deciduous wooded grassland, Wd)

SPECIES	Regional status	Tanzania	WdK (Kenya subtype)
Acacia mellifera	indicator species	f	C
Acacia nilotica	indicator species	C	C
Acacia reficiens	indicator species		C
Acacia tortilis	indicator species	C	C
Commiphora schimperi	indicator species	C	f
Cordia monoica	indicator species	x	f
Grewia arborea	indicator species	x	f
Salvadora persica	indicator species	f	C
Acacia drepanolobium		C	f
Acacia gerrardii		C	f
Acacia hockii		C	f
Acacia oerfota		f	C
Acacia polyacantha	riparian species in the Serengeti ecosystem	C	f
Acacia senegal		C	C
Acacia seyal		C	f
Acacia sieberiana	riparian species in the Serengeti ecosystem	C	f
Acacia xanthophloea	riparian species in the Serengeti ecosystem	C	f
Albizia amara	not characteristic	f	C
Balanites aegyptiaca		f	C
Croton dichogamus	not characteristic	f	C
Terminalia brownii		f	C

20. Biotic *Acacia* wooded grassland (We)

20.1. Description

Where domestic animals[7] are numerous, East African evergreen bushland (Be, see Volume 4) has been severely degraded and invaded by *Acacia* species. It is therefore typical to find *Acacia drepanolobium* (a species that also occurs in Somalia-Masai edaphic grassland [we]), *Acacia hockii, Acacia kirkii* and *Acacia seyal* (a species that also occurs in Somalia-Masai edaphic grassland [we])) occurring together with evergreen species such as *Carissa edulis*, *Dodonaea viscosa*, *Euclea divinorum*, *Euclea racemosa* and *Tarchonanthus camphoratus* (White 1983 p. 115). In the greater Serengeti region, *Acacia gerrardii* dominates secondary wooded grassland that replaces evergreen bushland, but it also occupies large areas of poorly drained clay soils (White 1983 p. 128).

Evergreen bushland (Be) communities of the Lake Victoria region have been extensively destroyed and replaced by a lightly wooded *Acacia* grassland dominated by *Acacia hockii, Acacia gerrardii, Acacia kirkii, Acacia senegal* (the latter also a characteristic species of deciduous bushland [Bd][8]) and *Euphorbia candelabrum* (also an emergent of evergreen bushland [Be]). White (1983 p. 182) cites references from Lebrun (1947, 1955) and Liben (1961) that suggest the pathways how evergreen thicket can regenerate within biotic *Acacia* wooded grassland. In one pathway, liana species germinate in the shade of the Acacias. These lianas eventually smother the crowns of the Acacias, which then creates suitable conditions for the establishment of shrubs and bushes. The shade from these shrubs and bushes finally completely suppresses the heliophilous ('sun-loving') Acacias that are no longer able to regenerate. In the alternative pathway, the shade from *Euphorbia candelabrum* causes a diminution in the vigour of the grass layer which then allows the invasion of woody plants (White 1983 p. 182).

We suggest that biotic *Acacia* wooded grassland is an **alternative steady state** of potential natural vegetation (corresponding to disturbance by animals) to the steady state of evergreen bushland (Be, corresponding to limited disturbance by animals). The degree of grazing pressure therefore determines the proportions of biotic *Acacia* wooded grassland compared to evergreen bushland (Be).

7: The same situation arises with wild animals

8: The variety of *Acacia senegal* var. *senegal* is a typical variety of biotic *Acacia* wooded grassland, whereas the variety of *Acacia senegal* var. *kerensis* is a typical variety of deciduous bushland (Bd; F. Gachathi, pers. comm.).

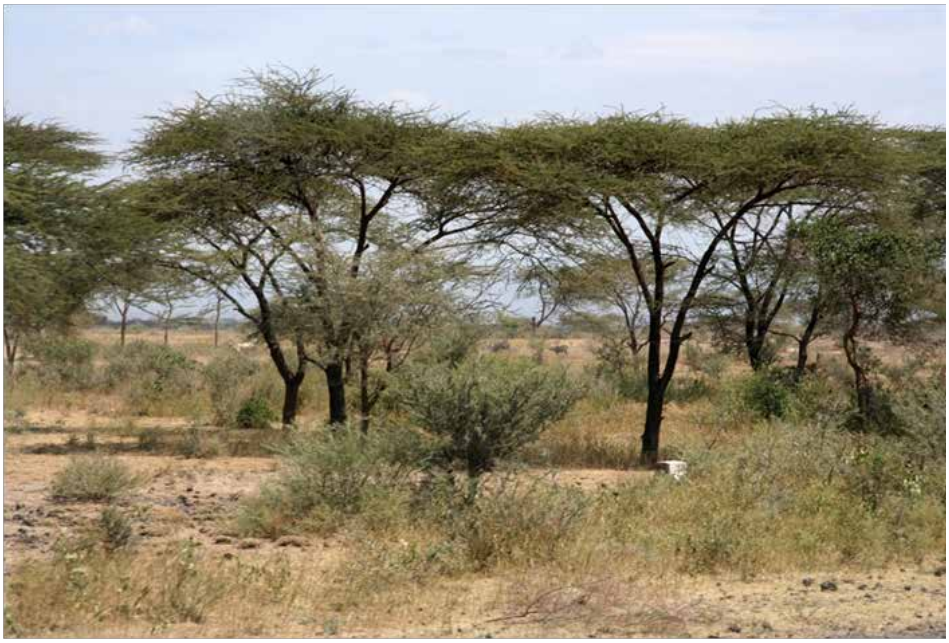

Figure 20.1. Vegetation that was originally classified as "*Acacia* wooded grassland of the Rift Valley" (ACB-RV) was reclassified by VECEA as biotic *Acacia* wooded grassland. Early dry season aspect with discontinuous ground cover. Awash National Park near the Fantale volcano (Ethiopia). Photograph by I. Friis and Sebsebe Demissew (October 2006). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 16A. 2010.

Figure 20.2. *Acacia senegal* var. *senegal* in Kajiado District (Kenya). The variety of *Acacia senegal* var. *senegal* is a typical variety of biotic *Acacia* wooded grassland, whereas the variety of *Acacia senegal* var. *kerensis* is a typical variety of deciduous bushland (Bd). Photograph by F. Gachathi (2008).

Figure 20.3. Vegetation that was originally classified as "*Acacia – Cymbopogon / Themeda* dry *Acacia* savanna" (original mapping unit P1; *Cymbopogon* and *Themeda* are grass genera) was reclassified as biotic *Acacia* wooded grassland by VECEA. The picture shows an area close to drier *Combretum* wooded grassland (Wcd) near Maddu (Uganda). Photograph by J. Kalema (November 2010).

Figure 20.4. Biotic *Acacia* wooded grassland in Akagera National Park (Rwanda). Photograph by C.K. Ruffo (October 2009).

Figure 20.5. *Acacia gerrardii – Acacia seyal* wooded grassland with Themeda grass understorey. Height of vegetation in meter. Pratt *et al.* (1966, Fig 3b). Image obtained from URL: *http://www.jstor.org/stable/2401259*

20.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 20. Species composition for biotic *Acacia* wooded grassland (We)

SPECIES	Regional status	Ethiopia	Kenya	Rwanda	Tanzania	WecU (Uganda subtype)	WesU (Uganda subtype)
Acacia gerrardii	indicator species	f	C	C	f	C	C
Acacia hockii	indicator species	f	C	x	f	x	x
Acacia kirkii	indicator species		C	C	f	f	f
Acacia senegal	indicator species	C	x	C	f	x	f
Acokanthera schimperi	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Capparis tomentosa	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Carissa spinarum	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Cussonia holstii	indicator species for evergreen and semi-evergreen bushland and thicket (transition to forest)	f	f	x	f	f	f
Dodonaea viscosa	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Elaeodendron buchananii	indicator species for evergreen and semi-evergreen bushland and thicket (transition to forest)	f	f	x	f	f	f
Euclea divinorum	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Euclea racemosa	indicator species for evergreen and semi-evergreen bushland and thicket	f	f	x	f	f	f
Euphorbia candelabrum	indicator species	C	x	C	f	x	f
Grewia bicolor	indicator species for evergreen and semi-evergreen bushland and thicket	f	x		f	f	f
Grewia similis	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Pterolobium stellatum	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	x	f	f	f
Rhus natalensis	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Schrebera alata	indicator species for evergreen and semi-evergreen bushland and thicket (transition to forest)	f	f	x	f	f	f
Scutia myrtina	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Tarenna graveolens	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	x	f	f	f
Acacia drepanolobium	characteristic species	f	C		f	f	x
Acacia seyal	characteristic species	C	C	C	f	f	x
Grewia tembensis	characteristic species for evergreen bushland and deciduous bushland	f	x				
Acacia brevispica		f	C	f	f	f	f
Acacia mellifera	not characteristic	f	C		f	f	f
Acacia polyacantha		f	C	C	f	f	f
Acacia sieberiana		f	x	C	f	x	f
Acacia tortilis	not characteristic	C	C		f	f	f
Acacia xanthophloea			C		f		
Albizia adianthifolia			f	C	f	x	f
Albizia amara	not characteristic	f	C	C	f	f	f
Allophylus rubifolius		f	x	x	f	f	f
Bersama abyssinica		f	x	x	f	f	f
Boscia angustifolia		f	x	x	f	f	f
Boscia salicifolia		f	x		f	f	x
Combretum molle		f	x	x	f	f	x
Commiphora habessinica		f	x	x	f	f	f
Cordia africana		f	x	x	f	f	f
Cussonia arborea		f	x	x	f	f	f
Dichrostachys cinerea		x	x	f	f	f	f
Dombeya buettneri		f		x			
Dombeya rotundifolia		f	x	x		f	f
Entada abyssinica		f	f	C	f	x	f
Erythrina abyssinica		f	x	x	f	f	f
Erythrina burttii			x				f
Faidherbia albida		C	x		f	f	f
Ficus glumosa		f	x	x	f	f	f
Gardenia ternifolia		f	x	x	f	x	f
Lannea fulva			f	x	f	f	f
Lannea humilis	not characteristic	f	f	x	f	f	x
Lannea schimperi		f	x	x	f	f	x
Lannea schweinfurthii		f	x	x	f	f	f
Maytenus senegalensis		x	x	x	f	x	f
Ozoroa insignis		f	x	x	f	f	f
Pappea capensis		f	x	x	f	f	f
Parinari curatellifolia			x	C	f	f	f
Senna didymobotrya		f	x	x	f	f	f
Terminalia brownii		x	x		f	f	f
Vangueria infausta			x	x	f	f	f
Ximenia americana		f	x	x	f	f	f
Ziziphus abyssinica		f	x	f	f	f	x
Ziziphus mucronata		f	x	x	f	f	f

21. Miombo woodland (Wm)

21.1. Description

Miombo woodland is floristically and physiognomically very different from other types of woodland. It is nearly always dominated by species of *Brachystegia* (we encountered 15 species when compiling national species compositions, see below) either alone or with *Isoberlinia angolensis*, *Julbernardia globiflora* or *Julbernardia paniculata*. The name "muyombo" (plural: "miyombo") is a Kinyamwezi name that refers to the tree *Brachystegia boehmii* (Lind and Morrison p. 81; one of our co-authors is a botanist and a Mnyamwezi who confirms the local name of this species). Because the dominant species are extremely gregarious, few other species enter the canopy (except in the more stunted variants). The appearance of miombo is distinctive because of the shape of the dominant trees with boles that are mostly short and relatively slender, with branches that are at first markedly ascending before spreading out to support a light, shallow and flat-topped crown and with leaves that are pinnate. Miombo woodland is mostly 10 to 20 m high, but scrub woodland can as short as 3 m. Most miombo woodlands are semi-deciduous, but some are completely deciduous and some are almost evergreen (White 1983 pp. 92 - 93). There is a marked flush of new leaves (of flaming reds, salmons, pinks and coppery tinges of all hues) just before the rains, a time during which miombo woodlands become especially beautiful (Burtt *et al.* 1942; Lind and Morrison 1974 p. 83).

Miombo woodland is the prevalent vegetation throughout the greater part of the Zambezian region, especially on the main plateau and its flanking escarpments where the soils are freely drained but the rooting environment is restricted. Miombo soils ofte have a restricted rootingenvironment [9] since they are shallow and stony, or since a laterite or gley horizon[10] occurs near the surface. On moister and deeper soils in higher rainfall areas, miombo has probably replaced Zambezian dry evergreen forest (Fm)[11] or Zambezian transition woodland (an ecotone in between Zambezian dry evergreen forest, see description of Zambezian dry evergreen forest) after cultivation and fire. Areas on certain deep soils where *Brachystegia longifolia*, *B. spiciformis* and *B. utilis* reach a height of 30 m are probably areas where miombo has replaced Zambezian dry evergreen forest[12] or Zambezian transition woodland (White 1983 p. 92).

Most of the dominant species of miombo woodland are widely distributed, have wide ecological amplitudes and combine in kaleidoscopic patterns. It is therefore difficult further subclassify miombo woodland based on distribution of the dominant species (but see below). However, it is possible to make a distinction between wetter miombo and drier miombo based on **associated vegetation types** (White 1983 p. 93):

- Wetter miombo woodland is associated with Zambezian dry evergreen forest and thicket (Fm), Zambezian swamp forest (fs), Zambezian evergreen riparian forest (fr) and wet dambos. Annual rainfall is usually more than 1000 mm, but less on Kalahari Sand.

9: This statement is very often not true as as soils under Miombo woodland can be very deep (even up to 8 m; J. Timberlake, personal communication).

10: The statements regarding stony or laterite/gley horizons may be true in plateau regions where miombo is relatively stunted and patchy. It is not the case on escarpment soils which are deep and stone free (P. Smith, pers. comm.). Whereas miombo of the Rift Valley escarpments and steeper hills slopes in Malawi are often on lithosols, this is not always the case. Deeper soils in Kasungu District (Malawi) are covered by typical miombo woodland (C. Dudley, pers. comm.).

11: The interpretation that areas within the Zambezian floristic region that have deeper soils would only have Zambezian dry evergreen forest as the climax vegetation type - and not Miombo woodland - is not generally accepted. It is known that Miombo woodland occurs in areas with deeper soils, and it is not certain that all these areas with deeper soils previously supported Zambezian dry evergreen forest (P. Smith and J. Timberlake, pers. comm.; see also comments for Zambezian dry evergreen forest in Volume 2).

12: Neither Trapnell thought nor I think that miombo has replaced dry evergreen forest. We think (thought) instead that Chipya woodland (Cy in the VECEA map) is part of that succession (P. Smith, personal communication).

Nearly all the dominant species of miombo woodland are included and *Brachystegia floribunda, B. glaberrima, B. taxifolia, B. wangermeeana* and *Marquesia macroura* (a principal canopy associate) are widespread.

- Drier miombo woodland is associated with Zambezian dry deciduous forest and thicket (Fn), Zambezian deciduous riparian forest (see fr) and dry dambos. Annual rainfall is less than 1000 mm. *Brachystegia boehmii, B. spiciformis and Julbernardia globiflora* are often the only dominants that are present, whereas *Brachystegia floribunda* is absent or very local.

Scrub miombo woodland occurs at high altitudes, on certain shallow soils and in ecotones between miombo woodland and dambo grassland. Towards the altitudinal limits of miombo (between 1600 and 2100 m), scrub miombo woodland occurs that is no more than 6 m tall and is usually dominated by *Brachystegia spiciformis* and more rarely by *Brachystegia floribunda, B. microphylla, B. taxifolia* or *Uapaca kirkiana* (a species that occurs scattered in miombo woodland as small trees). Scrub miombo woodland on shallow soils occurs on soils overlying laterite (3 m tall scrub woodland of *Brachystegia boehmii*) and soils derived from siltstone (3 to 5 m tall scrub woodland of *Brachystegia stipulata* and *Julbernardia globiflora*). Most of the dominant species of miombo woodland are usually absent from scrub miombo woodland (usually 4 to 7 m tall) at the edges of dambos, except for *Brachystegia boehmii* (White 1983 p. 99).

Zanzibar-Inhambane transition woodland (communities that are intermediate between forest and woodland where Zanzibar-Inhambane forest species occur together with heliophilous ['sun-loving'] Zambezian woodland species) is dominated by *Brachystegia spiciformis*. Some of these communities are stable, whereas others are clearly seral as forest encroachment can be observed (as some patches in the Shimba Hills where saplings of the forest species *Paramacrolobium coeruleum* [characteristic for moister variants of Zanzibar-Inhambane undifferentiated forest, Fp] form an almost pure understorey). *Brachystegia spiciformis* forms almost pure stands on white sterile sands where complete succession to forest is unlikely, as in the Arabuko-Sokoke forest (Fp; White 1983 p. 188).

The dominant species that were encountered when compiling the species composition for miombo include *Brachystegia allenii, Brachystegia boehmii, Brachystegia bussei, Brachystegia floribunda, Brachystegia glaberrima, Brachystegia glaucescens*[13], *Brachystegia longifolia, Brachystegia manga, Brachystegia microphylla, Brachystegia puberula, Brachystegia spiciformis, Brachystegia stipulata, Brachystegia taxifolia, Brachystegia utilis, Brachystegia wangermeeana, Isoberlinia angolensis, Julbernardia globiflora* and *Julbernardia paniculata.*

Among other *Brachystegia* species listed by White (1983 pp. 92 -93), *Brachystegia bakeriana* and *Brachystegia russelliae* occur in Zambia (based on information from the African Flowering Plants Database), but these are among a limited number of *Brachystegia* species that occur on Kalahari

13: *Brachystegia glaucescens* is now - incorrectly - treated as a synonym of *Brachystegia microphylla*. However, these species are morphologically and ecologically different (P. Smith and J. Timberlake, personal communication)

Sand (the most widespread species is *Brachystegia spiciformis*). *Brachystegia russelliae* is a geoxylic suffrutex (see descriptions of Kalahari woodlands [Wk]), whereas *Brachystegia bakeriana* is sometimes only 1.3 m high due to frost or unfavourable soil conditions(White 1983 pp. 92 and 98). *Brachystegia angustistipulata* and *Brachystegia torrei* are species that are confined to the eastern part of the Zambezian region (i.e. east of the Kalahari Sand) according to White; we have some evidence from the African Flowering Plants Database that *Brachystegia angustistipulata* occurs in Tanzania.

Figure 21.1. Wetter miombo woodland in Zambia (M. Bingham).

Figure 21.2. Wetter miombo woodland in Zambia. Annual grass fires are typical in miombo woodland. Usually not all grass burns each year. (M. Bingham)

Figure 21.3. Miombo woodland (probably near the foothill of Mt. Mulanje as this photograph was obtained from the Mulanje Mountain Conservation Trust; C. Dudley)

Figure 21.4. Some of the typical birds of miombo woodland in their natural habitat. Shell guide to East African birds (1960, reproduced with permission from URL *http://ufdc.ufl.edu/UF00077050).*

Figure 21.5. Profile diagram of Miombo woodland. Pratt et al. (1966, Fig 3a). Image obtained from URL: *http://www.jstor.org/stable/2401259*

Figure 21.6. *Brachystegia microphylla* upland woodland. *Brachystegia microphylla* is a miombo species that is virtually confined to rocky hills and escarpments (White 1983 p. 93). Gillman (1949, Fig 13).
Image obtained from URL: *http://www.jstor.org/stable/211155*

Figure 21.7. Miombo woodland near Morogoro (Tanzania). Photograph by Frank Mbago.

21.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 21. Species composition for Miombo woodland (Wm)

SPECIES	Regional status	Malawi	Tanzania	Zambia	WmrZ (Zambia subtype)	Wms (scrub miombo subtype)	Coast
Brachystegia allenii	dominant species (virtually confined to rocky hills and escarpments)	x	f	C	f		
Brachystegia boehmii	dominant species (both on escarpments, ridges and certain plateau soils; often one of the few dominant speciess of drier miombo; scrub woodland on shallow soils or at edges of dambos)	x	f	C		x	
Brachystegia bussei	dominant species (virtually confined to rocky hills and escarpments)	D	f	C	f		
Brachystegia floribunda	dominant species (more characteristic of deeper plateau soils; widespread in wetter miombo; absent or very local in drier miombo; sometimes in scrub woodland towards the altitudinal limits of miombo woodland)	x	f	C		x	
Brachystegia glaberrima	dominant species (more characteristic of deeper plateau soils; widespread in wetter miombo)		f	C			
Brachystegia glaucescens	dominant species (virtually confined to rocky hills and escarpments)	C		f	C		
Brachystegia longifolia	dominant species (more characteristic of deeper plateau soils; also present in northern Kalahari woodland)	x	f	C			
Brachystegia manga	dominant species (more characteristic of deeper plateau soils)	x	f	C			
Brachystegia microphylla	dominant species (virtually confined to rocky hills and escarpments; sometimes in scrub woodland towards altitudinal limits of miombo woodland)	D	f	f	C	x	C
Brachystegia puberula	dominant species (not east of Kalahari sands; also in northern Kalahari woodland)		f	f			
Brachystegia spiciformis	dominant species (more characteristic of deeper plateau soils; often one of the only dominant speciess of drier miombo; also in Kalahari woodland; dominant species in Zanzibar-Inhambane transition woodland; present in scrub woodland near the altitudinal limits of miombo woodland)	D	f	C		x	C
Brachystegia stipulata	dominant species (also present in scrub woodland on certain shallow soils derived from siltstone)	x	f	x		x	
Brachystegia taxifolia	dominant species (both on escarpments, ridges and certain plateau soils; widespread in wetter miombo; sometimes in scrub woodland towards altitudinal limits of miombo)		f	C	C	x	
Brachystegia utilis	dominant species (both on escarpments, ridges and certain plateau soils)	x	f	C			
Brachystegia wangermeeana	dominant species (more characteristic of deeper plateau soils; widespread in wetter miombo; also in northern Kalahari woodland)		f	C			
Isoberlinia angolensis	dominant species	D	f	C			
Julbernardia globiflora	dominant species (often one of the few dominant speciess of drier miombo woodland; also in scrub woodland on certain shallow soils derived from siltstone)	D	f	C		x	
Julbernardia paniculata	dominant species (also present in northern Kalahari woodland)	D	f	C			
Anisophyllea boehmii	indicator species	f	f	C			
Faurea saligna	indicator species	x	f	C			C
Marquesia macroura	indicator species		f	C			
Afzelia quanzensis	characteristic species	x	f	f			x
Burkea africana	characteristic species	C	f	f		x	
Dombeya rotundifolia	characteristic species	x		x			
Erythrophleum africanum	characteristic species	x	f	C			
Hymenaea verrucosa	characteristic forest species in Zanzibar-Inhambane transition woodland						x
Manilkara sansibarensis	characteristic forest species in Zanzibar-Inhambane transition woodland						x
Parinari curatellifolia	characteristic species	x	f	C		x	f
Pericopsis angolensis	characteristic species	x	f	C			
Pseudolachnostylis maprouneifolia	characteristic species	x	f	x			
Pterocarpus angolensis	characteristic species	x	f	C			f
Terminalia sericea	characteristic species	x	f	f			
Acacia nigrescens	not characteristic	C	f	f			
Acacia polyacantha	not characteristic	x	f	f			f
Acacia sieberiana	not characteristic	x	f	f			f
Albizia amara	not characteristic	x	f	f			
Albizia antunesiana	not characteristic	x	f	x			
Albizia versicolor	not characteristic	x	f	f			f
Anisophyllea boehmii	not characteristic		f	x			
Bauhinia petersiana		x	f	x			
Bobgunnia madagascariensis	not characteristic	x	f	x		x	
Cassia abbreviata	not characteristic	x	f	f			f
Combretum adenogonium	not characteristic	x	f	x			
Combretum collinum	not characteristic	x	f	x			f
Combretum molle	not characteristic	x	f	f			f
Combretum zeyheri		x	f	x			f
Cryptosepalum exfoliatum	not characteristic	f	f	x	C		
Cussonia arborea		x	f	x			
Dalbergia nitidula		x	f	x			f
Dichrostachys cinerea		x	f	x			f
Diospyros kirkii		x	f	x			
Diplorhynchus condylocarpon	not characteristic	x		x			
Faurea rochetiana	species that occurs in scrub woodland at edges of dambos		f	x		x	
Flacourtia indica		x	f	x			f
Hexalobus monopetalus		x	f	x			
Kigelia africana	not characteristic	x	f	f			f
Kirkia acuminata	not characteristic	C	f	f			
Landolphia kirkii		f	f	x			f
Lannea discolor	not characteristic	x		f			
Lannea schweinfurthii	not characteristic						x
Lonchocarpus capassa	not characteristic	x	f	f			f
Markhamia obtusifolia	not characteristic	x	f	x			f
Monotes africanus		x		f			
Ormocarpum kirkii		x	f	f			f
Oxytenanthera abyssinica	(lowland bamboo species)	x	f	f			

SPECIES	Regional status	Malawi	Tanzania	Zambia	WmrZ (Zambia subtype)	Wms (scrub miombo subtype)	Coast
Ozoroa insignis	not characteristic	x	f	f			f
Piliostigma thonningii	not characteristic	x	f	f			f
Sclerocarya birrea	not characteristic						x
Securidaca longipedunculata		x	f	x			f
Smilax anceps	not characteristic		f	x			
Strychnos cocculoides		x	f	x			f
Strychnos innocua		x	f	x			f
Syzygium guineense	not characteristic	f	f	C		x	f
Thespesia garckeana	not characteristic	x	f	f			
Uapaca kirkiana	species that occurs scattered in miombo as small trees; sometimes in scrub woodland near altitudinal limits of miombo woodland	x	f	x		x	
Uapaca nitida		x	f	x			f
Vangueriopsis lanciflora	not characteristic	x	f	f		x	
Vitex mombassae		x	f	x			f
Xeroderris stuhlmannii	not characteristic	x	f	f			f
Ziziphus abyssinica	not characteristic	x	f	f			f
Ziziphus mucronata	not characteristic	x	f	f			f

22. Palm wooded grassland physiognomically easily recognized type, P)

22.1. Description

White (1983) did not describe palm wooded grasslands as a separate vegetation type in his main treatment of floristic regions. However, he describes *Hyphaene coriacea* palm stands that occur on sites with permanent ground water at the edge of the Chalbi desert and at the base of Mt. Kulal (White 1983 p. 123). *Borassus aethiopum* and *Hyphaene petersiana* (synonym: *Hyphaene ventricosa*) are among the characteristic species of the riparian woodland subtype of Undifferentiated woodland and wooded grassland (Wn, White 1983 p. 95). *Borassus aethiopum* is listed to occur in seasonally inundated flood plains in the Sudanian floristic region (White 1983 p. 107). *Borassus aethiopum* and *Hyphaene thebaica* occur on transition zones between swamp grassland and better drained areas with *Acacia seyal* in the flood region of the Nile (White 1983 p. 108). *Hyphaene compressa* occurs in Zanzibar-Inhambane edaphic wooded grassland (White 1983 p. 189). *Phoenix reclinata* and *Raphia farifera* are palm species that are listed among the more important species of swamp forests that are widespread in the Lake Victoria region and elsewhere (White 1983 p. 181). *Phoenix reclinata* occurs in swamp forests in the Zanzibar-Inhambane region (White 1983 p. 188).

Lind and Morrison (1974 p. 94) mention that palm wooded grassland is limited in area, but so noticeable that it needed to be included in descriptions of East African vegetation types. The main species is *Borassus aethiopum*. In Uganda, it is found on sands and sandy loams with mobile ground water. In Kenya, it is scattered through the coastal belt and is noticeable on the Shimba Hills. In Tanzania, extensive stands occur in the flood plains of the Igombe and Ugala rivers and other riverine communities where it is sometimes accompanied by *Hyphaene* doum palm species. *Hyphaene coriacea* is the dominant palm species on the Ruaha - Usangu plain complex and in the Warmi and Mkata flood plains. *Borassus* stands are more common than *Hyphaene* in parts of the coastal plain, but small trees (up to 3 m) of *Hyphaene* form extensive stands in grassland on poorly drained sands.

From the descriptions above it is clear that the palm stands that were described often occur in areas with drainage impediments or riverine locations. It would therefore be perfectly acceptable to classify and map these vegetation types as "edaphic wooded grassland" (wd) or "riverine wooded grassland" (wr), which we have done in several situations. We think that discrimination between these types is more a question of the scale of mapping since palm trees can easily be identified in the field.

Figure 22.1. *Borassus - Hyperthelia dissoluta* [a grass species, synonym: *Hyparrhenia dissoluta*,] palm wooded grassland (original mapping unit M2) from Uganda. Photograph by J. Kalema.

Figure 22.2. Stand of *Phoenix reclinata* in waterlogged area within Afromontane rain forest (Fa). Photograph by I. Friis and Sebsebe Demissew. Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 25G. 2010.

Figure 22.3. *Hyphaene petersiana* wooded grassland next to the Shire River marsh and lagoons (Liwonde National Park, Malawi). An alternative classification method for this vegetation type would have been as "edaphic wooded grassland on drainage-impeded or seasonally flooded soils". Photograph by C. Dudley.

22.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 22. Species composition for Palm wooded grassland physiognomically easily recognized type, P)

SPECIES	Regional Status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	P1U (Uganda subtype	P2U (Uganda subtype	Zambia	Coast
Borassus aethiopum	Palm species (occurs in the riparian woodland subtype of north Zambezian undifferentiated woodland, in Sudanian edaphic grassland on Pleistocene clays, and in Zanzibar-Inhambane secondary grassland and wooded grassland)	C	C	f		f	D	D	f	C
Cocos nucifera	Palm species (occurs in Zanzibar-Inhambane edaphic grassland and secondary grassland)		C			f				C
Elaeis guineensis	Palm species		C	f		f	f	f		C
Hyphaene compressa	Palm species (occurs in Zanzibar-Inhambane edaphic grassland and secondary grassland)	C	C			f				C
Hyphaene coriacea	Palm species (small stands with permanent ground water at the edge of the Chalbi desert and at the base of Mt. Kulal)		C			f				C
Hyphaene petersiana	Palm species (occurs in the riparian woodland subtype of north Zambezian undiffertiated woodland)			D		f			C	
Hyphaene thebaica	Palm species (occurs in Sudanian undifferentiated woodland and in Sudanian edaphic grassland on Pleistocene clays)	C								
Phoenix reclinata	Palm species (small communities in areas with frequent landslides on Mt. Kulal, Lake Victoria swamp forest, Zanzibar-Inhambane swamp forest	C	C	f	C	f	f	f	f	C
Raphia farinifera	Palm species (occurs in Lake Victoria swamp forest)		C	f		f	f	f	f	C
Acacia erioloba									C	
Acacia nigrescens				C					f	
Acacia polyacantha				f			x	x	f	
Acacia sieberiana				C			x	x	f	
Acacia xanthophloea				C						
Adansonia digitata				C					f	
Albizia versicolor				C			f	f	f	
Burkea africana				f			f	f	C	
Combretum collinum				f			x	x	f	
Diospyros mespiliformis				C			f	f	f	
Faidherbia albida				C			f	f	f	
Kigelia africana				C				x	f	
Lannea schweinfurthii				C			f	f	f	
Lonchocarpus capassa				C					f	
Piliostigma thonningii				C			x	x	f	
Sterculia africana				C					f	
Terminalia sericea				f					C	
Trichilia emetica				C			f	f	f	

23. Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, wd)

23.1. Description

It is not always easy to discriminate between riverine wooded grasslands and edaphic wooded grasslands (there is a similar problem in differentiating riverine forest from swamp forests, see Volume 2). We were probably not consistent in allocating mapping units from national maps to riverine or edaphic wooded grasslands, but where proximity to a river was obvious, we preferred the classification of riverine wooded grasslands. The edaphic wooded grasslands that we classified as such typically contained *Acacia* species. Wooded grasslands dominated by palm species are sometimes riverine or indicative of conditions of impeded drainage, but we classified these vegetation types separately (VECEA mapping unit "P", see section 15) since they are easy to be distinguished in the field, from aerial photographs or even some satellite imagery.

White (1983) did not strictly apply a differentiation between edaphic wooded grassland (with cover percentages of 10 - 40% woody species) and edaphic grassland (with cover percentages of <10% woody species) since both types intergrade and edaphic wooded grasslands are often difficult to delimit from the more open grasslands with which they are associated (White 1983 pp. 50 - 52). **Within the VECEA map, we loosely defined "edaphic wooded grassland" as "edaphic grassland with scattered woody species" and "edaphic grassland" as "edaphic grassland without scattered woody species". This means that some vegetation types that would have been classified as "edaphic grasslands" in a strict physiognomic classification system (i.e. woody cover < 10%) may have been allocated to "edaphic wooded grasslands".**[14]

Although White (1983) described edaphic grasslands and wooded grasslands separately for the various floristic regions, we did not apply a floristic classification system to edaphic grasslands and edaphic wooded grasslands (although we directly relied on the information that was provided by White in descriptions of a particular floristic region).

Edaphic grassland areas of the Zambezian region were mapped and described as grasslands, including suffrutex grassland areas that are considered as wooded grasslands (mapping unit g, see Volume 5) by some authors.

In the Somalia-Masai region, water-receiving depressions covered with black and cracking clays are extensively developed in Central Tanzania; these depressions do not have sufficient run-off to carve stream beds and quickly evaporate in the dry season. The principal grasses that cover these depres-

14: The definition of "grasslands" of Pratt et al. (1966) of "land dominated by grasses and occasionally other herbs; sometimes with widely scattered or grouped trees and shrubs, the canopy cover of which does not exceed 2%" may therefore provide a more accurate physiognomic definition of vegetation types that were classified as "edaphic grassland" by the VECEA project.

sions ("mbugas" [15]) are *Setaria incrassata* and *Themeda triandra*. The *mbugas* are treeless but are usually separated by an ecotone of wooded grassland that is dominated by various gall *Acacia* species, including *Acacia drepanolobium, Acacia malacocephala, Acacia pseudofistula* and *Acacia seyal*. Seasonally waterlogged (wooded) grassland also occurs as ill-defined glades on non-cracking calcimorphic "hard pan" soils within deciduous bushland (Bd). The dominant grass species in these glades are dwarf grasses, including *Microchloa indica*. The glades do not have trees or have scattered individuals of *Acacia drepanolobium, Acacia mellifera, Acacia tanganyikensis, Acacia tortilis, Albizia amara, Albizia harveyi, Commiphora schimperi, Dalbergia melanoxylon, Lannea humilis, Sclerocarya birrea* and *Terminalia stuhlmannii*. Ill-defined areas of inland drainage in Somalia are covered with *Cynodon dactylon* and *Chloris roxburghiana* and have scattered *Acacia tortilis* (White 1983 p. 116).

Various types of edaphic wooded grassland are described for the Sudanian floristic region, including those occurring on the Pleistocene clays of the Nile Valley. Within the flood region, areas of slightly higher grounds that are only flooded to a shallow depth and where annual rainfall is in between 570 and 1000 mm are covered with *Acacia seyal*. The transition zones in between swamp grasslands (containing *Setaria incrassata*) and the better drained areas are sometimes dominated by the palm species *Borassus aethiopum* and *Hyphaene thebaica*, either single or together (White 1983 p. 108).

Zanzibar-Inhambane edaphic (wooded) grassland cover large areas of grey-black cracking clay soils near the mouth of the Tana river. These grasslands are studded with thicket-covered termite mounds (described separately as Termitary vegetation [T, see Volume 4]). There are widely spaced individuals of *Acacia zanzibarica*, *Hyphaene compressa, Terminalia spinosa* and *Thespesia danis* (White 1983 p. 189).

15: The definition given (White 1983 p. 269) is of "water-receiving depressions in East Africa covered with grassland and Acacia-wooded grassland on seasonally satured, black, cracking clays. Mostly occurring at low altitudes and under a drier and hotter climate than dambos".

Figure 23.1Profile diagram of seasonally waterlogged wooded grassland with *Acacia drepanolobium*. Height of vegetation in meter. The grass species is *Pennisetum mezianum*. Pratt et al. (1966, Fig 5b). Image obtained from URL: *http://www.jstor.org/stable/2401259*.

Figure 23.2. Edaphic wooded grassland with *Acacia drepanolobium* in Nairobi National Park (Kenya). Photograph by F. Gachathi (2009).

Figure 23.3. *Acacia seyal* var. *seyal* in Moyale District (Kenya) in an area with impeded drainage. Photograph by F. Gachathi (2009).

Figure 23.4. Typical East African bird species of edaphic wooded grassland within their habitat. Shell guide to East African birds (1960, reproduced with permission from URL *http://ufdc.ufl.edu/UF00077050)*.

Figure 23.5. Partly flooded "wooded grassland of the western Gambela region" with *Acacia nilotica, Acacia seyal* and *Balanites aegyptiaca*. West of Itang. Altitude approximately 450 m (September 1996). Photograph by I. Friis and Sebsebe Demissew. Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 17B. 2010.

Figure 23.6. *Acacia paolii* is common in places with black cotton soil (vertisols) that occur within *Acacia-Commiphora* bushland (Bd). In the original vegetation map of Ethiopia (Friis *et al*. 2010), areas with edaphic wooded grassland on black cotton soils that occur within areas of *Acacia-Commiphora* deciduous bushland (Bd) were not mapped separately in their " *Acacia-Commiphora* woodland and bushland proper" mapping unit; these include areas of *Acacia drepanolobium* (Friis *et al*. 2010 Fig 15E) and *Acacia paolii* (Friis *et al*. 2010 Fig 15G). Photograph by I. Friis and Sebsebe Demissew. Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 15G. 2010.

23.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 23. Species composition for Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, wd)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	wdeT (Tanzania subtype)	wdnT (Tanzania subtype)	wdU (Uganda)	Zambia	Coast
Acacia drepanolobium	Somalia-Masai edaphic grassland	C	C		C	C	C		
Acacia gerrardii		f	C	f	f	f	x	f	f
Acacia malacocephala	Somalia-Masai edaphic grassland		x		C	f			
Acacia mellifera	Somalia-Masai edaphic grassland; scattered bushes in edaphic grassland of the Serengeti plains; Pleistocene clays of the Nile valley	C	C		f	C	f	f	f
Acacia nilotica		C	x	f	f	f	f	C	f
Acacia paolii		C	x						
Acacia polyacantha		f	C	f	f	f	C	C	f
Acacia pseudofistula	Somalia-Masai edaphic grassland		x		C	f			
Acacia senegal		C	f		f	f	x	f	f
Acacia seyal	Somalia-Masai edaphic grassland; Pleistocene clays of the Nile Basin	C	C	f	C	f	C	C	
Acacia sieberiana		f	C	f	f	f	C	C	f
Acacia tanganyikensis	Somalia-Masai edaphic grassland		x		f	C			
Acacia tortilis	Somalia-Masai edaphic grassland	f	x		f	C	f	f	f
Acacia xanthophloea			x	C	f	f			f
Acacia zanzibarica	Zanzibar-Inhambane edaphic grassland	f	f		f	f			C
Albizia amara	Somalia-Masai edaphic grassland	f	x	f	f	C	x	f	
Albizia harveyi	Somalia-Masai edaphic grassland		x	f	f	C	f	f	f
Andropogon kelleri	seasonally waterlogged grassland in Somalia with scattered Acacia tortilis		x						
Aristida adscensionis	seasonally waterlogged grassland in Somalia		x						
Balanites aegyptiaca	Sudanian grassland on shallow soil over ironstone	x	x		f	f	C	f	
Balanites rotundifolia		f	x				x		f
Bauhinia petersiana				f	f	f		C	
Blepharis acanthodioides	Somalia-Masai edaphic grassland		x						
Borassus aethiopum	Sudanian valley and floodplain edaphic grassland; Sudanian wooded edaphic grassland on pleistocene clays; palm species	C	f	f	f	f	f	f	f
Bothriochloa bladhii			f	x	f	f	x		
Cenchrus ciliaris	seasonally waterlogged grassland in Somalia		x		f	f	f		
Chloris gayana			x	x	f	f	f		
Chloris roxburghiana	seasonally waterlogged grassland in Somalia with scattered *Acacia tortilis*		x		f	f	f		
Chrysopogon plumulosus	seasonally waterlogged grassland in Somalia		x		f	f			
Combretum adenogonium		f	f	f	f	f	C	C	
Commiphora schimperi	Somalia-Masai edaphic grassland	f	x		f	C	f		
Cynodon dactylon	seasonally waterlogged grassland in Somalia		x		f	f	f		
Dactyloctenium aegyptium			x	x	f	f	f		
Dalbergia melanoxylon	Somalia-Masai edaphic grassland	f	x	f	f	C	f	f	f
Diospyros kirkii				f	f	f	f	C	
Faidherbia albida		f	f	f	f	f	f	C	f
Gardenia ternifolia	Sudanian grassland on shallow soil over ironstone	f	f		f	f	x		f
Harrisonia abyssinica		x	f	f	f	f	x	f	f
Hyparrhenia rufa			f	x	f	f	x		
Hyphaene compressa	Zanzibar-Inhambane edaphic grassland, palm species	f	f		f	f			C
Hyphaene petersiana	(palm species)			C	f	f		f	
Hyphaene thebaica	Sudanian edaphic wooded grassland on pleistocene clays; palm species	C							
Kyllinga alba	Somalia-Masai edaphic grassland		x						
Lannea humilis	Somalia-Masai edaphic grassland	f	x		f	C	x	f	
Leersia hexandra			f	x	f	f	x		
Microchloa indica	Somalia-Masai edaphic grassland		x		f	C			
Oryza longistaminata		C							
Panicum coloratum	seasonally waterlogged grassland in Somalia		x		f	f	f		
Piliostigma thonningii		x	f	f	f	f	C	C	f
Pseudocedrela kotschyi	Sudanian grassland on shallow soil over ironstone	f					x		
Sclerocarya birrea	Somalia-Masai edaphic grassland	f	x	f	f	C	f	f	f
Setaria incrassata	Somalia-Masai edaphic grassland; Pleistocene clays of the Nile Basin		x	x	x	f	x		
Setaria sphacelata			f		f	f	x		x
Sorghum purpureo-sericeum	grass species that occurs in Pleistocene clays of the Nile basin		f		f	f	x		
Sporobolus pyramidalis			f	x	f	f	x		
Terminalia spinosa	Zanzibar-Inhambane edaphic grassland	f	f		f	f	f		C
Terminalia stenostachya				f	f	f		C	
Terminalia stuhlmannii	Somalia-Masai edaphic grassland		x		f	C		f	
Thalia geniculata		C							
Themeda triandra	Somalia-Masai edaphic grassland; edaphic grasslands of the Serengeti plains; Zambezian edaphic grassland		x		x	f	x		
Thespesia danis	Zanzibar-Inhambane edaphic grassland	f	f		f	f			C

24. Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd)

24.1. Description

Within volumes 2 to 5, we use the synonym of "deciduous bushland (Bd)" as a synonym of "Somalia-Masai *Acacia-Commiphora* **deciduous bushland and thicket (Bd)".**

Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket is the climax vegetation type over the greater part of the Somalia-Masai floristic region. It characteristically is a dense bushland of 3 to 5 m tall with scattered emergent trees up to 9 m. Emergent species are only a few species that have well-defined trunks which carry the crown well above the main canopy; they are virtually absent from the driest areas. Most of the characteristic species of the main canopy are multiple-stemmed bushes or small bushy trees that are branched near the base. In higher rainfall areas (especially on rocky hills), the emergent trees occur closer together and are somewhat larger (but only exceptionally taller than 10 m). Some authors have categorized this physiognomic variant as woodland. Locally thickets are formed that are impenetrable. Even when canopy cover is less than 40 percent, but where grasses are inconspicuous (such as the ephemeral species of *Aristida adscensionis*, *Aristida congesta, Brachiaria eruciformis and Brachiaria leersioides* and the short-lived perennial species of *Cenchrus ciliaris*, *Chloris roxburghiana* and *Schmidtia pappophoroides*) and most of the phytomass consists of bushes (as in many places within deciduous bushland), it would be misleading to classify this vegetation as wooded grassland. In areas where rainfall is somewhat less than 250 mm per year (but probably more than 200 mm - see Somalia-Masai semi-desert grassland and shrubland [S]), the vegetation of 2 to 3 m high bushes and stunted trees (principally of *Acacia reficiens* ssp. *misera*) is intermediate between bushland and shrubland (White 1983 pp. 113 - 114).

There is appreciable variation in floristic composition, but species of *Acacia*, *Commiphora*, *Grewia* and various Capparidaceae species [*e.g. Boscia, Cadaba* and *Maerua*][16] are nearly always present. The dominant *Acacia* species and some of the *Commiphora* species are spinous. Some *Commiphora* species and *Terminalia orbicularis* have several massive branches that radiate from a common base. Most species are deciduous (loosing their leaves simultaneously and usually for several weeks or months [White 1983 p. 46]). Evergreen species occur throughout, but never contribute more than 10 percent of phytomass (White 1983 p. 113).

White (1983 p. 48) describes the African pattern that where annual rainfall is between 250 and 500 mm and where there are two rainy seasons, deciduous bushland and thicket communities of regional extent (such as Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket) occur. Where annual rainfall is also between 250 and 500 mm, but falls entirely in the summer -

16: Lind and Morrison (1974 p. 60) mention that members of the Capparidaceae family are common and include species of *Boscia, Cadaba* and *Maerua***.** These are sometimes spiny and can be recognized by their showy flowers with many stamens and succulent, berry-like fruits on long stalks. These authors also refer to *Grewia* species that are commonly found and are often in flower (most have yellow or white flowers with many stamens, but the common *Grewia similis* has bright mauve flowers).

as in the Sahel and Kalahari-Highveld floristic transition zones, grasses are favoured on sandy soils and the most widespread vegetation type becomes wooded grassland.

White (1983 p. 114) describes deciduous bushland that occurs in Tsavo National Park (between Garissa and Voi in Kenya) as typical. Most of the species that White (1983) listed as characteristic were indicator species (see also section 3.2). Only four species (including three climbers) were also listed as characteristic species for evergreen bushland (Be): *Cissus quadrangularis* and *Cissus rotundifolia* (climbers listed for this vegetation type occurring in the Lake Victoria region), *Grewia tembensis* (listed as a smaller bush and shrub for deciduous bushland and as a large bush in East African evergreen bushland) and *Sarcostemma viminale* (a climber listed for this vegetation type occurring in East Africa).

The indicator species can be further categorized in: (i) characteristic species of the main canopy; (ii) emergent species; (iii) smaller bushes and shrubs; (iv) succulents; and (v) climbers.

- Characteristic species of the main canopy include[17]: *Acacia bussei, Acacia mellifera* (also scattered in Somalia-Masai edaphic grassland), *Acacia nilotica, Acacia reficiens, Acacia thomasii, Balanites rotundifolia, Boscia coriacea* (evergreen, often one of the few species that are not eliminated by elephants in severely degraded bushland), *Boswellia neglecta, Cadaba farinosa, Cadaba heterotricha, Cassia abbreviata, Commiphora africana, Commiphora campestris, Commiphora edulis, Commiphora erythraea, Commiphora mollis, Commiphora schimperi* (also scattered in Somalia-Masai edaphic grassland), *Cordia monoica, Cordia sinensis, Dobera glabra, Dobera loranthifolia* (evergreen), *Euphorbia scheffleri, Givotia gosai, Hymenodictyon parvifolium, Lannea alata, Lannea triphylla, Platycelyphium voense, Premna hildebrandtii, Salvadora persica* (evergreen), *Sesamothamnus rivae, Sterculia africana, Sterculia rhynchocarpa, Sterculia stenocarpa, Terminalia orbicularis, Terminalia parvula* and *Thylachium thomasii.*
- Emergent species include *Acacia tortilis* (also scattered in Somalia-Masai edaphic grassland), *Adansonia digitata* (often only 8 m tall with a short but massive trunk), *Delonix elata, Euphorbia robecchii* (a candelabra-like succulent), *Melia volkensii* (this species persists longer than most woody species in degraded bushland) and *Terminalia spinosa.*
- Smaller bushes and shrubs include *Bauhinia taitensis, Bridelia taitensis, Caesalpinia trothae, Carphalea glaucescens, Caucanthus albidus, Combretum aculeatum, Ecbolium amplexicaule, Erythrochlamys spectabilis, Grewia fallax, Grewia tembensis, Grewia tenax, Grewia villosa, Maerua deinhardtiorum, Premna resinosa, Sericocomopsis hildebrandtii* and *Sericocomopsis pallida.*
- Succulents include *Adenium obesum, Calyptrotheca somalensis, Calyptrotheca taitensis, Euphorbia grandicornis, Euphorbia nyikae* (a candelabra-like succulent that is more restricted than *Euphorbia robechii*), *Euphorbia robecchii* (a candelabra-like succulent that also

17. White (1983 p. 114) did not list *Acacia senegal* among the characteristic species of the main canopy. However, this is probably an oversight since *Acacia senegal* is listed as one of the dominant species of deciduous bushland in Marsabit district (White 1983 p. 121). *Acacia senegal* var. *kerensis* is a typical constituent of deciduous bushland and the main producer of gum arabic in Kenya. The variety of *Acacia senegal* var. *senegal* is a typical variety of biotic Acacia wooded grassland (We; F. Gachathi, pers. comm.).

is an emergent), *Euphorbia quinquecostata* (a candelabra-like succulent that is more restricted than *Euphorbia robechii*) and *Monadenium invenustum*.

- Climbers include *Adenia globosa* (a climber with enormous half-submerged water storing tubers), *Gerrardanthus lobatus, Kedrostis gijef, Pergularia daemia, Pyrenacantha malvifolia* (a climber with enormous half-submerged water storing tubers, often one of the few remaining species in severely degraded bushland) and *Thunbergia guerkeana*.

24.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Figure 24.1. *Acacia-Commiphora* deciduous bushland 57 km from Konso on route to Yabello (Ethiopia). Photograph by Sebsebe Demissew (May 2008).

Figure 24.2. *Acacia-Commiphora* bushland on fine-grained reddish sand. The photograph was taken near Yabelo (Ethiopia) after a rainy season with above-average rainfall. Altitude approximately 1600 metres. Photograph by I. Friis and Sebsebe Demissew (November 1997). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 15B. 2010.

Figure 24.3. Partly exposed tubers of *Pyrenacantha malviifolia* in the underground of *Acacia-Commiphora* deciduous bushland (Bd), here partly on black cotton soil (vertisol). Near Sof Omar (Ethiopia). Altitude approximately 1500 metres. White (1983 p. 114) described this species as a climber with enormous half-submerged water storing tubers and often one of the few remaining species in severely degraded Somalia-Masai *Acacia-Commiphora* deciduous bushland. Photograph by I. Friis and Sebsebe Demissew (October 1984). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 15H. 2010.

Figure 24.4. *Acacia-Commiphora* deciduous bushland in Garbatula (Kenya). The species in the foreground is *Commiphora holtziana*. The emergent tree at the right is *Acacia tortilis*. Photograph by F. Gachathi (2011).

Figure 24.5. *Commiphora africana* is a typical species of *Acacia-Commiphora* deciduous bushland. The image above shows the species during the dry season (Garbatula, Kenya, photograph taken in 2011), whereas the image below shows the species during the wet season (Samburu district, Kenya, photograph taken in 2009). Photographs by F. Gachathi.

Figure 24.6. *Commiphora holtziana* produces opoponax (hagar). This species can dominate large sections of *Acacia-Commiphora* bushland in Kenya as in Garbatula shown here. Photograph by F. Gachathi (2011).

Figure 24.7. *Acacia senegal* var. *kerensis* is a typical constituent of *Acacia-Commiphora* deciduous bushland and thicket, as in the thicket shown here from Isiolo District (Kenya). This species is the main producer of gum arabic in Kenya. Another variety of this species, *Acacia senegal* var. *kerensis*, is typical of biotic Acacia wooded grassland (We, see Volume 3). Photograph by F. Gachathi (2008).

Figure 24.8. *Acacia reficiens* ssp. *misera* can form almost uniform stands as shown here in Garbatula (Kenya).

Figure 24.9. White (1983 p. 114) describes that *Acacia reficiens* ssp. *misera* is the typical stunted tree species of vegetation that is intermediate between bushland and shrubland (in VECEA, this vegetation type was mapped as the "stunted bushland" subtype of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket [Bds]). Photographs taken by F. Gachathi (2011).

Table 24. Species composition for Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd)

SPECIES	Regional status	Ethiopia	Kenya	Kenya (BdsK subtype)	Tanzania	Uganda	Uganda (BdvU subtype)	Uganda (BdrU subtype)
Acacia bussei	indicator species	C	x	x	f		C	
Acacia mellifera	indicator species	x	x	x	x	C	C	C
Acacia nilotica	indicator species	x	x	x	f	C	x	x
Acacia reficiens	indicator species	C	x	x	f	C	C	
Acacia thomasii	indicator species		x					
Acacia tortilis	indicator species	C	x	x	x	C	C	C
Adansonia digitata	indicator species	f	x		x			
Adenia globosa	indicator species	x	x		f			
Adenium obesum	indicator species	x	x			x	x	
Balanites rotundifolia	indicator species	C	x	x		C	x	
Bauhinia taitensis	indicator species		x					
Boscia coriacea	indicator species	x	x	x	f	f		
Boswellia neglecta	indicator species	C	x	C	f	x		
Bridelia taitensis	indicator species		x					
Cadaba farinosa	indicator species	f	x	x	f	x	x	x
Cadaba heterotricha	indicator species	x	x					
Caesalpinia trothae	indicator species	x	x		f			
Calyptrotheca somalensis	indicator species	x	x					
Calyptrotheca taitense	indicator species		x					
Carphalea glaucescens	indicator species	x	x		f			
Cassia abbreviata	indicator species		x		f			
Caucanthus albidus	indicator species	x	x					
Combretum aculeatum	indicator species	C	x		f	f		
Commiphora africana	indicator species	x	x	x	f	C	x	x
Commiphora campestris	indicator species	C	x		f	x	C	
Commiphora edulis	indicator species	C	x		f	C		
Commiphora erythraea	indicator species	x	x	x				
Commiphora mollis	indicator species		x		f			
Commiphora schimperi	indicator species	x	x		f	C		
Cordia monoica	indicator species	x	x		f	f		
Cordia sinensis	indicator species	x	x	x	x	f	x	
Delonix elata	indicator species	x	x	x	f	f		
Dobera glabra	indicator species	x	x	x	f	f		
Dobera loranthifolia	indicator species		x		f			
Ecbolium amplexicaule	indicator species		f		x			
Erythrochlamys spectabilis	indicator species	x	x					
Euphorbia grandicornis	indicator species		x			x	x	
Euphorbia invenusta	indicator species		f					
Euphorbia nyikae	indicator species		x		x			
Euphorbia quinquecostata	indicator species		x		f			
Euphorbia robecchii	indicator species	x	x		f			
Euphorbia scheffleri	indicator species	x	x		f			
Gerrardanthus lobatus	indicator species		x		f	f		
Givotia gosai	indicator species	x	x					
Grewia arborea	indicator species		x		f	f		
Grewia tenax	indicator species	x	x	x	f	x	C	
Grewia villosa	indicator species	x	x	x	f	x	x	

SPECIES	Regional status	Ethiopia	Kenya	Kenya (BdsK subtype)	Tanzania	Uganda	Uganda (BdvU subtype)	Uganda (BdrU subtype)
Hymenodictyon parvifolium	indicator species		x		f	f		
Kedrostis gijef	indicator species		x		f			
Lannea alata	indicator species		x		f			
Lannea triphylla	indicator species	x	x		f	C	C	C
Maerua deinhardtiorum	indicator species	x	x					
Melia volkensii	indicator species	x	x		f			
Pergularia daemia	indicator species	x			f			
Platycelyphium voense	indicator species	x	x		f			
Premna hildebrandtii	indicator species		x		f			
Premna resinosa	indicator species	x	x		f	f		
Pyrenacantha malvifolia	indicator species	x	x		f			
Salvadora persica	indicator species	x	x	x	x	f		
Sericocomopsis hildebrandtii	indicator species	x	x	x	f	x		
Sericocomopsis pallida	indicator species	x	x	x	f			
Sesamothamnus rivae	indicator species	x	x		f	x		
Sterculia africana	indicator species	x	x		f			
Sterculia rhynchocarpa	indicator species	x	f		f	x		
Sterculia stenocarpa	indicator species	x	x		f	f		
Terminalia orbicularis	indicator species	C	x					
Terminalia parvula	indicator species		x					
Terminalia spinosa	indicator species	x	x	x	f	f		
Thilachium thomasii	indicator species		x					
Thunbergia guerkeana	indicator species		x		f			
Cissus quadrangularis	characteristic species		x		x	x	x	
Cissus rotundifolia	characteristic species	x	x		f	x	x	
Grewia tembensis	characteristic species	x	x	x				
Sarcostemma viminale	characteristic species	x	f			x	x	
Acacia asak		x						
Acacia brevispica		x	x	x	f	C	C	
Acacia drepanolobium		C	x	x	x	x		x
Acacia gerrardii		f	x		f	x		
Acacia hockii		f	x		f	C		
Acacia lahai		x	x		f	f		
Acacia oerfota		x	x	x	f	f	C	
Acacia paolii		x	x	x				
Acacia senegal		x	x	x	f	C		
Acacia seyal		x	x		x	C	C	C
Albizia amara		f	x	x	f	C		
Albizia anthelmintica		x	x		f	x	x	
Allophylus rubifolius		x	x		f	f		
Balanites aegyptiaca		C	x	x	f	C	x	x
Balanites glabra		x	x		f			
Berchemia discolor		x	x		f	f		
Boscia angustifolia		x	x		f	x		
Boscia salicifolia		x	x		f	f		
Boswellia microphylla		C	x	x				
Boswellia rivae		x	x					

SPECIES Regional status	Ethiopia	Kenya	Kenya (BdsK subtype)	Tanzania	Uganda	Uganda (BdvU subtype)	Uganda (BdrU subtype)
Calotropis procera	x	x	x	f	f		
Canthium lactescens	x	x		f	f		
Capparis tomentosa	C	x		f	f		
Carissa spinarum	x	x		f	f		
Commiphora habessinica	x	x		x	C	x	
Commiphora myrrha	C	x					
Commiphora rostrata	C	x					
Dichrostachys cinerea	x	f		f	C		
Erythrina burttii		x		f			
Erythrina melanacantha	x	x		f			
Euclea divinorum	x	x		f	f		
Euphorbia candelabrum	x	x		x	C	C	
Euphorbia tirucalli	x	x		x	f		
Faidherbia albida	x	x		f	f		
Gardenia volkensii	x	x		f	f		
Grewia bicolor	x	x		f	f	x	
Grewia similis	f	x		f	x	C	
Harrisonia abyssinica	x	x		f	f		
Hyphaene compressa (palm species)	x	x	x	f			
Hyphaene thebaica (palm species)	x	f	x				
Lannea humilis	x	f		f	C	C	C
Lannea rivae	x	x		f			
Lawsonia inermis	x	x	x	f	f		
Maerua decumbens	x	x		f	f		
Maytenus senegalensis	x	x		f	f		
Opilia campestris	x	x		f			
Ormocarpum kirkii		x		f			
Ormocarpum trachycarpum	x	x		f	f		
Ormocarpum trichocarpum	x	x		f	x		
Otostegia integrifolia	x						
Ozoroa insignis	x	f		f	x		
Phoenix dactylifera		x		f			
Plectranthus barbatus	x	f		f	C	C	
Psydrax schimperiana	x	x		f	f		
Rhus natalensis	x	x	x	f	x	x	
Sclerocarya birrea	f	x		f	C		
Senna alexandrina	x	x					
Steganotaenia araliacea	x	x		f	x		
Tarenna graveolens	x	f		f	x		
Terminalia brownii	x	f		f	C		
Terminalia prunioides	x	x		f			
Ximenia americana	x	x		f	x		
Zanthoxylum chalybeum	x	x	x	f	C	x	
Ziziphus mauritiana	x	x		f	f		
Ziziphus mucronata	x	x		f	f		
Ziziphus spina-christi	x	x		f	f		

25. Evergreen and semi-evergreen bushland and thicket (synonym: evergreen bushland, Be)

25.1. Description

Within volumes 2 to 5, we use the synonym of "evergreen bushland (Be)" as a synonym of "evergreen and semi-evergreen bushland and thicket (Be)".

White (1983) describes evergreen and semi-evergreen bushland and thickets within the descriptions of two floristic regions: (i) the Somalia-Masai regional centre of endemism ('East African evergreen and semi-evergreen bushland and thicket'); and (ii) the Lake Victoria regional mosaic ('evergreen and semi-evergreen bushland and thicket and derived communities').

Evergreen and semi-evergreen bushland and thicket occurs on the drier slopes of mountains and upland areas in East Africa which rise from the lowlands from the Somalia-Masai region all the way from central Tanzania to Eritrea (and beyond). It often forms an ecotone between Afromontane forest (especially Afromontane single-dominant *Juniperus procera* forest [Fbj]) and deciduous bushland (Bd) - this pattern of occurrence can be clearly observed in northern Kenya such as at on the lower slopes of Mt. Marsabit (2º 16' N, 37º 57' E). The mean annual rainfall is mostly between 500 and 850 mm and is irregularly distributed throughout the year but with two main peaks (White 1983 pp. 48 and 115).

Evergreen bushland varies greatly in composition and richness, but certain species that are nearly always present include *Acokanthera schimperi, Carissa spinarum, Dodonaea viscosa, Euclea divinorum, Euphorbia candelabrum, Olea europaea* **ssp.** *cuspidata* (synonym: *Olea africana*), *Tarchonanthus camphoratus* (especially in disturbed areas), *Vepris simplicifolia* (synonym: *Teclea simplicifolia*) together with other species of *Acokanthera, Aloe, Euclea, Euphorbia, Sanseviera* and *Vepris*. Succulents such as *Dracaena ellenbeckiana* and *Euphorbia candelabrum* that are present in evergreen bushland are absent from Afromontane single-dominant *Juniperus procera* forest (Fbj, White 1983 p. 115).

Evergreen bushland (in mosaic with Lake Victoria *Euphorbia dawei* scrub forest [fe, see Volume 2] that is edaphically restricted to rocky slopes) probably represents the climax vegetation of large parts of the Lake Victoria region. This evergreen bushland variant is floristically similar but also floristically poorer than the vegetation type with the same name that occurs in the Somalia-Masai region. The principal bushy species include *Allophylus africanus, Azima tetracantha, Carissa spinarum* (also listed as characteristic in East Africa), *Capparis fascicularis* (listed as a characteristic climber in East Africa), *Capparis tomentosa, Erythrococca bongensis, Grewia bicolor, Maerua triphylla, Olea europaea* **ssp.** *cuspidata* (synonym: *Olea africana*, also

listed as characteristic in East Africa), *Psydrax schimperiana*, *Rhus natalensis* (also listed as characteristic in East Africa), *Tarenna graveolens* and *Turraea nilotica*.

Annual rainfall is higher in places where evergreen bushland occurs in the Lake Victoria region (850 mm to 1000 mm) than those places where it occurs in the Somalia-Masai region (500 to 850 mm; White 1983 pp. 48 and 182).

Where evergreen bushland is degraded (as a result from grazing), various *Acacia* species invade and **biotic Acacia wooded grassland (We)** becomes established. This vegetation type forms an alternative steady state of potential natural vegetation to evergreen bushland (*i.e.* it is possible for both types of potential natural vegetation to become established in the areas where they are mapped separately).

The grasslands of the Loita and other plains that occur in Narok district (including parts of the Masai-Mara reserve) are similar in grass species composition as the edaphic grasslands on volcanic soils of the Serengeti plains (gv, see Volume 5). However, these grasslands in Narok district are secondary to evergreen bushland as a result from fire and browsing (White 1983 p. 127). Areas capable of supporting evergreen bushland in Nairobi National Park have been converted to grassland as a result from browsing, grazing and fire (White 1983 p. 116).

White (1983) describes relatively undisturbed evergreen bushland (locally impenetrable) that occurred near Nairobi between 1875 and 2080 m. Most of the species that White (1983) listed as characteristic were indicator species (see also section 4.3). Only two species were also listed as characteristic species for deciduous bushland (Bd): *Grewia tembensis* (listed as a smaller bush and shrub for deciduous bushland and thicket, and as a large bush in East African evergreen bushland) and *Sarcostemma viminale* (a succulent climber).

The indicator species can be further categorized in: (i) characteristic species of the main canopy; (ii) other large bushes; (iii) scattered emergents; (iv) shrubs; (v) climbers; and (vi) scattered stunted individuals that indicate the transition to Afromontane single-dominant *Juniperus procera* forest (Fbj).

- Characteristic species of the main canopy (3 to 7 m) include *Acokanthera schimperi*, *Euclea divinorum*, *Gnidia subcordata*, *Olea europaea* **ssp.** *cuspidata* (synonym: *Olea africana*], also listed as characteristic species for the Lake Victoria region), *Tarchonanthus camphoratus* (especially in disturbed areas) and *Vepris simplicifolia*. (White (1983) did not list *Carissa spinarum*, but this could be an omission).
- Other large bushes include *Canthium keniense*, *Croton dichogamus*, *Dodonaea viscosa*, *Dombeya burgessiae*, *Grewia similis*, *Maytenus heterophylla* and *Rhus natalensis* (also listed as characteristic species for the Lake Victoria region).
- *Euphorbia candelabrum* (a cactoid stem-succulent) occurs throughout as a scattered emergent up to 9 m tall. This species was

also listed as a characteristic species for the Lake Victoria region.

- Shrubs include *Aspilia mossambicensis, Psiadia punctulata, Tinnea aethiopica* and *Turraea mombassana.*
- Climbers include *Capparis fascicularis* (also listed as characteristic species for the Lake Victoria region), *Pterolobium stellatum* and *Scutia myrtina.*
- Scattered stunted individuals that indicate the transition to Afromontane single-dominant *Juniperus procera* forest (Fbj) appear at higher altitudes and include *Calodendrum capense, Cussonia holstii, Drypetes gerrardii, Elaeodendron buchananii, Juniperus procera* (evergreen bushland could be the original habitat of this species [White 1983 p. 165]) and *Schrebera alata.*

Figure 25.1. Evergreen thicket in Queen Elizabeth National Park (Uganda). Emergent *Euphorbia candelabrum* covered by climbers can be seen in various places. Photograph by M. Namaganda (June 2008).

Figure 25.2. Evergreen and semi-evergreen bushland next to a remnant of Afromontane single-dominant *Juniperus procera* forest (Fbj). Near Arero (Ethiopia). Approximate altitude 1800m. Photograph by I. Friis and Sebsebe Demissew (September 2002). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 23A. 2010.

Figure 25.3. Stands of *Dracaena ombet* subsp. *ombet* in *Acacia*-dominated bushland below remnants of Afromontane single-dominant *Juniperus procera* forest (Fbj). Between Wukro and Berahile (Ethiopia). Approximate altitude 1700 m. Photograph by I. Friis and Sebsebe Demissew (October 2009). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 23B. 2010.

Figure 25.4. Regrowth of *Tarchonanthus camphoratus* in evergreen bushland in a transition zone between *Acacia-Commiphora* deciduous bushland and Afromontane single-dominant *Juniperus procera* forest (Fbj). Between Wukro and Berahile (Ethiopia). Approximate altitude 2000 m. (October 2009). Photograph by I. Friis and Sebsebe Demissew. Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 23D. 2010.

Figure 25.5. Evergreen bushland and thicket in Biharagu (Rwanda). Photograph taken by E. Munyaneza (October 2009).

Figure 25.6. Evergreen bushland was the original vegetation type of most of the Akagera National Park (Rwanda). Photograph by V. Minani (March 2007).

Figure 25.7. As a result from grazing, the original evergreen bushland of Akagera national park (Rwanda) has changed to the alternative steady state of biotic Acacia wooded grass-land (We). Climbers growing on Euphorbia candelabrum (right) can initiate the vegetation succession to evergreen bushland (see also Lebrun [1947] and White [1983 p. 183]; Photograph by D. König (September 1987).

Figure 25.8. Evergreen bushland in the Maasai Mara (original mapping unit 24). The photograph shows Diospyros abyssinica together with typical evergreen bushland species of *Euclea divinorum, Olea europaea* ssp. *cuspidata* (synonym: *Olea africana*). Person: C.G. Trapnell. Photography by E.C. Trump.

25.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 25. Species composition for Evergreen and semi-evergreen bushland and thicket (synonym: evergreen bushland, Be)

SPECIES	Regional status	Ethiopia	Kenya (BeeK subtype)	Kenya (BewK subtype)	Rwanda	Tanzania	Uganda (BemU subtype)	Uganda (BedU subtype)
Acokanthera schimperi	indicator species	C	x	x	x	f	f	f
Allophylus africanus	indicator species	f	f	x	f	f	x	C
Aloe kedongensis	indicator species		x					
Aspilia mossambicensis	indicator species	f	f	f		f	f	f
Azima tetracantha	indicator species			x	x		f	f
Canthium keniense	indicator species		x					
Capparis fascicularis	indicator species	f	x	x	x	f	f	x
Capparis tomentosa	indicator species	f	x	x	C	f	f	x
Carissa spinarum	indicator species	f	x	x	C	x	x	x
Croton dichogamus	indicator species	f	x	x	x	x	f	
Dodonaea viscosa	indicator species	C	x	x	f	f	f	f
Dombeya burgessiae	indicator species		x	f	f	f	f	
Dracaena ellenbeckiana	indicator species	C	x	f		f	f	
Erythrococca bongensis	indicator species	f	f	x	x	f	f	
Euclea divinorum	indicator species	C	x	x	x	x	x	f
Euphorbia candelabrum	indicator species	f	x	x	f	x	x	C
Gnidia subcordata	indicator species		x	x		f	f	
Grewia bicolor	indicator species	f	x	x		f	f	f
Grewia similis	indicator species	x	x	x	C	x	C	x
Maerua triphylla	indicator species	f	x	x	x	f	f	
Maytenus heterophylla	indicator species	f	x	f	x	f	f	
Olea europaea	indicator species	C	x	x	C	x	f	f
Psiadia punctulata	indicator species	x	x			f		
Psydrax schimperiana	indicator species	f	x	x	x	f	f	f
Pterolobium stellatum	indicator species	f	x	x	f	f	f	f
Rhus natalensis	indicator species	f	x	x	x	x	x	f
Scutia myrtina	indicator species	f	x	x	x	f	x	f
Tarchonanthus camphoratus	indicator species	C	x	x		f	f	
Tarenna graveolens	indicator species	x	x	x	x	C	f	x
Tinnea aethiopica	indicator species	f	x	x		f	f	x
Turraea mombassana	indicator species	x	x			f		
Turraea nilotica	indicator species	f	f	x		f		
Vepris simplicifolia	indicator species	f	x	x		x		
Vernonia brachycalyx	indicator species	f	f	x	x	f	C	f
Acacia drepanolobium	characteristic species	f	C	f		f	f	f
Acacia gerrardii	characteristic species	f	C	x	f	x	f	x
Acacia hockii	characteristic species	f	C	x	f	f	f	x
Acacia kirkii	characteristic species		x	x	f	f	f	f
Acacia senegal	characteristic species	f	x	x	f	f	f	C
Acacia seyal	characteristic species	f	x	C		f	f	f
Calodendrum capense	characteristic species		x	f		f	f	f
Cissus quadrangularis	characteristic species		x	x	x	f	f	
Cissus rotundifolia	characteristic species	f	f	x		f	x	x
Cussonia holstii	characteristic species	C	x	x	x	f	f	f
Drypetes gerrardii	characteristic species		x	f	C	f	f	
Elaeodendron buchananii	characteristic species	f	x	f	x	x	f	f
Grewia tembensis	characteristic species	x	x	f				

SPECIES	Regional status	Ethiopia	Kenya (BeeK subtype)	Kenya (BewK subtype)	Rwanda	Tanzania	Uganda (BemU subtype)	Uganda (BedU subtype)
Juniperus procera	characteristic species	C	x	f		f	f	f
Sarcostemma viminale	characteristic species	f	f	f	x			
Schrebera alata	characteristic species	C	x	f	x	f	f	f
Acacia brevispica		f	C	C	x	x	C	C
Acacia lahai		f	x	x		f	f	f
Acacia mellifera	not characteristic	f	C	f		f	f	f
Acacia nilotica	not characteristic	f	x	f		f	f	x
Acacia polyacantha		f	x	x	f	f	f	f
Acokanthera oppositifolia	characteristic genus		f	x				
Albizia amara	not characteristic	f	x	f	f	f	f	x
Albizia coriaria		f	f	C		f	x	f
Albizia zygia			f	f		f	x	x
Allophylus rubifolius		f	x	x	x	f	f	f
Annona senegalensis		f	x	x	f	f	f	f
Antidesma venosum		f	f	x		f	x	f
Apodytes dimidiata		f	x	x	x	f	f	f
Balanites aegyptiaca		f	x	f	f	f	f	x
Berberis holstii		C	f	f		f	f	f
Berchemia discolor		C	f	f		f	f	f
Boscia angustifolia		f	f	f	x	f	f	x
Bridelia micrantha		f	x	x	f	f	f	f
Bridelia scleroneura		f	f	f		f	x	C
Cadaba farinosa	not characteristic	f	f	x	x	f	f	f
Canthium lactescens		x	x	f	x	f	C	f
Catha edulis		C	x	f	f	f	f	f
Clausena anisata		f	x	x	x	f	f	f
Clerodendrum myricoides		x	x	x	x	f	f	f
Combretum molle		f	x	f	x	f	f	f
Commiphora africana	not characteristic	x	f	f	f	f	f	x
Cordia monoica	not characteristic	f	x	x		x	f	f
Crotalaria agatiflora		f	x	x	f	f	f	f
Croton macrostachyus		f	x	x	x	f	f	f
Cussonia arborea		f	x	x	x	f	f	f
Dichrostachys cinerea		f	f	x	f	f	f	x
Dombeya rotundifolia		x	x	x	f		f	f
Dovyalis abyssinica		f	x	x		f	f	f
Erythrina abyssinica		f	x	x	f	f	f	f
Euclea racemosa	characteristic genus	C	x	x	x	C	x	f
Euphorbia tirucalli		x	x	x	x	f	x	x
Faurea rochetiana		f	x	f	x	f	f	f
Faurea saligna			x	x	f	f	f	f
Ficus glumosa		f	x	x	f	f	f	f
Flacourtia indica		f	x	x	x	f	f	f
Gardenia ternifolia		f	x	x	f	f	f	f
Grewia mollis		f	x	x	f	f	C	C
Harrisonia abyssinica		f	x	x	x	f	x	C
Indigofera swaziensis			x	x		f	f	f

SPECIES	Regional status	Ethiopia	Kenya (BeeK subtype)	Kenya (BewK subtype)	Rwanda	Tanzania	Uganda (BemU subtype)	Uganda (BedU subtype)
Lannea fulva			f	f	x	f	f	f
Lannea humilis	not characteristic	f	x	f	f	f	f	x
Lannea schweinfurthii		f	x	f	f	x	f	x
Lecaniodiscus fraxinifolius		f	x	x		f	f	f
Lippia kituiensis			x	x		f		
Maytenus senegalensis		f	x	f	x	f	f	f
Maytenus undata		f	x	f	x	f	f	f
Oncoba spinosa		f	x	x		f	f	f
Ormocarpum kirkii			x	f		f		
Osyris lanceolata		f	x	f	x	f	f	f
Ozoroa insignis		f	x	x	f	f	f	f
Pappea capensis		C	x	x	x	x	f	f
Pavetta crassipes		f	x	x		f	f	f
Pistacia aethiopica		C	x	f		f	f	f
Pittosporum viridiflorum		C	x	f	x	f	f	f
Rhamnus staddo		f	x	f	x	f	f	f
Rhoicissus revoilii		f	f	x	x	f	f	f
Rhoicissus tridentata		f	x	x	x	f	x	x
Rhus vulgaris		f	x	x	x	f	f	f
Senna didymobotrya		x	x	f	f	f	f	f
Solanecio cydoniifolius			x	f	x	f	f	f
Solanecio mannii		f	x	f	x	f	f	f
Steganotaenia araliacea		f	f	x	f	f	f	x
Stereospermum kunthianum		f	x	x		f	f	x
Strychnos henningsii		f	x	f		x	f	f
Terminalia brownii		f	x	x		f	f	f
Tetradenia riparia		f	x	x	f			
Vangueria apiculata		f	x	x	x	f	x	f
Vangueria infausta			x	x	x	f	f	f
Vangueria madagascariensis		x	x	x		f	x	f
Vepris nobilis	characteristic genus (synonym: Teclea)	f	x	x	x	C	C	f
Vepris trichocarpa	characteristic genus (synonym: Teclea)		x		x	C		x
Zanthoxylum chalybeum		f	x	f	x	f	f	x
Zanthoxylum usambarense		C	f	f	f	f		
Ziziphus abyssinica		f	x	x	f	f	f	C
Ziziphus mucronata		f	x	x	f	x	f	f
Ziziphus pubescens		f	x	x		f	x	f

26. Montane Ericaceous belt (easily identifiable type, E)

26.1. Description

White (1983) refers to Afromontane evergreen bushland and thickets that occur on most of the higher African mountains and that characteristically occupy a large part of the Ericaceous mountain belt. They are also found on the crests and summits of smaller mountains (especially those that are situated close to the ocean or a large lake) or locally on shallow soils within the Afromontane forest belt. Where the ground is not very rocky and has been protected for several years, such as on wetter mountains as the Ruwenzori Mts., almost impenetrable thickets of 3 to 13 m are formed. On drier and rocky slopes, the vegetation is an open community of bushes that is often discontinuous and merges into Afromontane shrubland (see below). Afromontane evergreen bushland and thicket varies greatly in floristic composition, but species of the *Blaeria*, *Erica* and *Vaccinium* Ericaceae genera are nearly always present and sometimes exclusively dominant (White 1983 p. 167 - 168). Hedberg (1951 cited in Friis *et al.* 2010 p. 113) has documented that an Ericaceous belt occurs on all the high mountains of eastern Africa.

Afromontane shrubland occurs on shallow soils and especially exposed rocky ridges. It is much shorter than Afromontane evergreen bushland and thicket and contains stunted invididuals that are dominant in the latter vegetation type. However, Afromontane shrubland also contains species that are usually absent from Afromontane evergreen bushland and thicket (White 1983 p. 168).

Ericaceous vegetation occurs at a few places on the East African coast. Evergreen bushland dominated by *Erica* (synonym: Philippia) occurs on waterlogged sites of former lagoons or lake basins (White 1983 p. 188). Interestingly, *Syzygium cordatum* is an associate that is listed both for Ericaceous vegetation on Mafia and Pemba islands (White 1983 p. 189) and for tall "elfin" thickets (3 - 7 m) that occur on peaks in the Uluguru mountains (White 1983 p. 168). We did not include coastal Ericaceous vegetation types into the "montane Ericaceous belt" as coastal vegetation is clearly not associated with mountains.

Figure 26.1. Ericaceous belt with *Erica arborea* forming woodland. The floor is completely covered by ferns, mosses and grasses. Bale Mountains (Ethiopia). Approximate altitude 3600 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 29A. 2010.

Figure 26.2. Ericaceous belt with *Erica arborea* forming woodland. This location has more grass than the location shown in Fig EA. Bale Mountains (Ethiopia). Approximate altitude 3300 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 29C. 2010.

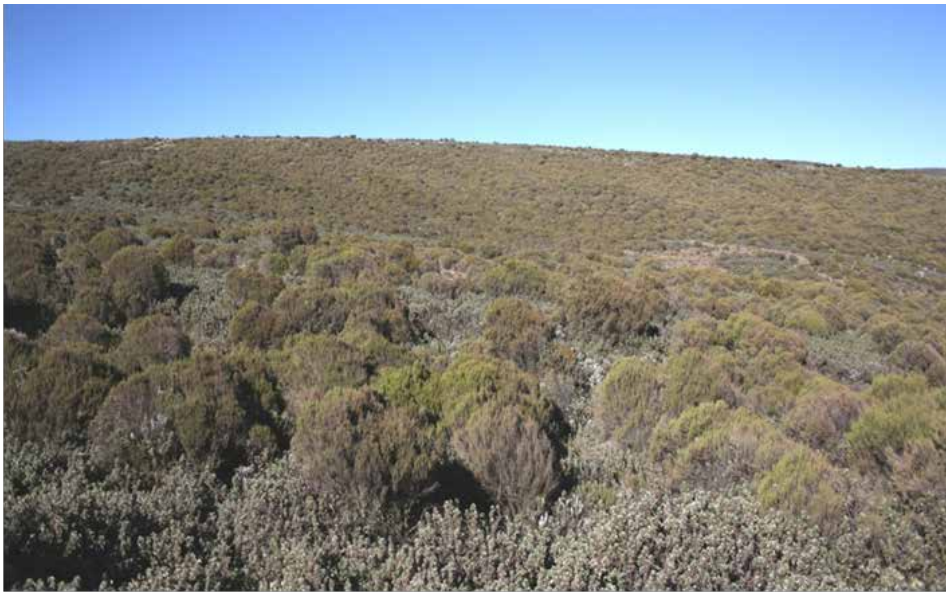

Figure 26.3. Ericaceous belt with burnt vegetation. Numerous shoots (green) appear from the burnt stumps of *Erica arborea*. In between the *Erica arborea* stumps and in the foreground, the subshrub *Alchemilla haumannii* (greyish-green) can be seen. Bale Mountains (Ethiopia). Approximate altitude 3800 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 29B. 2010.

Left: Figure 26.4. The montane Ericaceous belt on Mt. Kahuzi (Kahuzi-Biega-National Park, D.R.Congo. Photograph by E. Fischer (October 1991).

Right: Figure 26.5. *Vaccinium stanleyi*, one of the Ericaceae species of the Ericaceous belt in Rwanda (Mt. Kahuzi, Kahuzi-Biega-National Park, D.R.Congo). Photograph by E. Fischer (October 1991).

Figure 26.6. *Erica kingaensis* subsp. *ruggensis*, one of the Erica species of the Ericaceous belt in Rwanda. Rwasenkoko Swamp, Nyungwe National Park. Photograph by E. Fischer (October 1985).

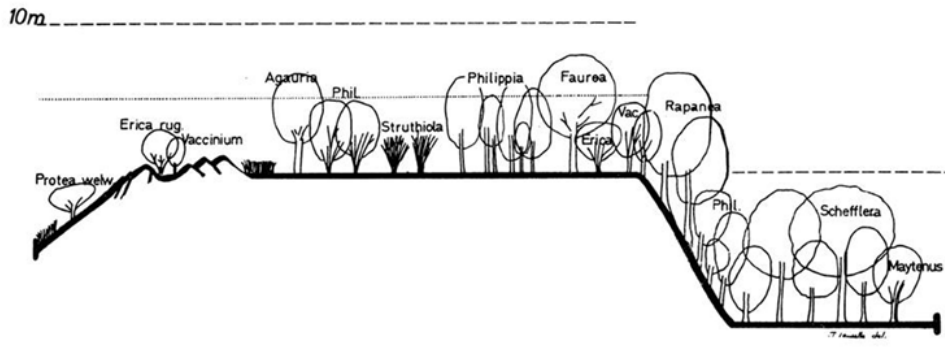

Figure 26.7. Profile diagram of Afromontane Ericaceous bushland ("fruticée sclérophylle à Ericaceae", i.e. sclerophyl scrubland with Ericaceae). This image was the only profile diagramme mentioned by White (1983 p. 167) for Afromontane evergreen bushland and thicket. Vegetation similar to the Ericaceous belt occurs on the crests and summits of some smaller mountains as shown below. Lewalle 1972 Fig 28. Figure obtained from URL URL: http://www.jstor.org/stable/3667406

26.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 26. Species composition for Montane Ericaceous belt (easily identifiable type, E)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda
Adenocarpus mannii		x	x	f	f	C	f
Agauria salicifolia	Ericaceae	f	C	f	C	f	f
Berberis holstii		x	x	f		f	f
Clematis simensis		x	x		f	f	f
Discopodium eremanthum		x	x			f	f
Dombeya torrida		x	x	f	f	f	f
Erica arborea	Ericaceae	C	C		f	C	x
Erica benguelensis	Ericaceae		f	C	f	f	C
Erica johnstoniana	Ericaceae			f			C
Erica johnstonii	Ericaceae				f		x
Erica kingaensis	Ericaceae				f	f	x
Erica milanjiana	Ericaceae			x			
Erica rossii	Ericaceae		C			C	
Erica trimera	Ericaceae	C	C			f	C
Erica whyteana	Ericaceae		f	x		f	
Faurea saligna			x	f	f	f	x
Gnidia glauca		x	x	f		f	f
Hagenia abyssinica		x	x	f	f	f	f
Hypericum revolutum		C	x	f	f	f	x
Morella salicifolia		x					
Rapanea melanophloeos		C	x	f	f	f	f
Rhus glutinosa		x					

27. *Termitaria* vegetation (easily identifiable and edaphic type, including bush groups around *termitaria* within grassy drain age zones, T)

27.1. Description

Termite mounds that are more than a metre in diameter are usually covered with dense thickets, unless they have been newly built or are in the final stages of erosion. The species composition of these thickets is completely different from that on the surrounding soil. This pattern is particularly true for the Zambezian region where the flora of termite-mound thickets is extremely high (with more than 700 woody species occurring in this habitat in Zambia alone; White 1983 p. 98).

In the Zambezian region, the flat valley bottoms of larger rivers are usually flooded annually or at least seasonally waterlogged. Where the flood water is shallow, "bush-group" grassland often occurs extensively; this is a mosaic of pure grassland and termite-mound thicket (White 1983 p. 100). A similar pattern occurs in the Zanzibar-Inhambane region where dense thickets occur in seasonally-waterlogged grasslands in parts of the coastal plain (White 1983 p. 189). This vegetation type could potentially be described as "wooded grassland", but treating it as a patchwork or mosaic of pure edaphic grassland and sharply defined islands of thickets that occur on the better drained soils of old eroded termite mounds gives a better description of this vegetation type.

From the widespread species that White (1983) listed, the following species were encountered in the Zambian national reference: *Carissa spinarum, Diospyros lycioides, Euphorbia candelabrum, Flueggea virosa, Peltophorum africanum, Rhoicissus tridentata, Steganotaenia araliacea* and *Strychnos potatorum* (White 1983 p. 98).

Figure 27.1. Lateral view of a large example of mopane *termitaria* vegetation. The large trees are mopane (roughly 25 m). Photograph by C. Dudley.

Figure 27.2. *Termitaria* vegetation in Kafue National Park (Zambia). The sides with a south-western exposure carry trees, whereas the sides with a north-eastern exposure carry only grassland. Cole 1963 Fig 9. Image obtained from URL: http://www.jstor.org/stable/1794828.

Figure 27.3. T. Mopane termitaria vegetation result in a distinct pattern on aerial photographs. Each patch of Mopane termitaria vegetation is between 10 and 20 m in diameter. Photograph by C. Dudley.

27.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 27. Species composition for *Termitaria* vegetation (easily identifiable and edaphic type, including bush groups around *termitaria* within grassy drainage zones, T)

SPECIES	Regional status	Malawi	Zambia	Coast
Colophospermum mopane	dominant species of Mopane woodland	C	C	
Abutilon angulatum		f	x	
Acacia gerrardii			x	f
Acacia nigrescens		x	C	
Acacia nilotica			x	f
Albizia amara			C	
Albizia anthelmintica		x	x	f
Allophylus africanus		x	x	
Antidesma venosum			x	f
Apodytes dimidiata			C	f
Balanites aegyptiaca			x	
Bauhinia petersiana			x	
Berchemia discolor		f	x	f
Boscia angustifolia			C	f
Boscia salicifolia			x	f
Capparis tomentosa		f	x	f
Carissa spinarum	widespread species in Zambezian termite-mound thicket		x	f
Cassia abbreviata		x	x	f
Combretum imberbe			C	f
Combretum molle			C	f
Commiphora africana			x	
Dalbergia melanoxylon		x	x	f
Dichrostachys cinerea			x	f
Diospyros bussei	emergent trees overtopping thickets on termite mounds in seasonally-waterlogged grassland in the Zanzibar-Inhambane region			C
Diospyros consolatae	thickets on termite mounds in seasonally-waterlogged grassland in the Zanzibar-Inhambane region			C
Diospyros lycioides	widespread species in Zambezian termite-mound thicket		x	
Diospyros mespiliformis		f	C	f
Dobera glabra	emergent trees overtopping thickets on termite mounds in seasonally-waterlogged grassland in the Zanzibar-Inhambane region		x	C
Dombeya kirkii		f	x	
Dombeya rotundifolia			x	
Entandrophragma caudatum			x	
Erythrina abyssinica			C	f
Erythrophleum suaveolens			C	f
Euclea divinorum			x	f
Euclea natalensis	thickets on termite mounds in seasonally-waterlogged grassland in the Zanzibar-Inhambane region; characteristic genus in Zambezian termitaria		x	C
Euclea racemosa			x	f
Euphorbia candelabrum	widespread species in Zambezian termite-mound thicket		C	f
Ficus sycomorus			x	f
Flacourtia indica			x	f
Flueggea virosa	widespread species in Zambezian termite-mound thicket		x	f
Garcinia livingstonei			C	f
Grewia bicolor		x	x	
Kigelia africana		f	x	f
Kirkia acuminata		f	C	
Landolphia kirkii			x	f
Lannea discolor			x	
Lannea schweinfurthii		x	C	f
Lonchocarpus capassa		f	x	f
Manilkara mochisia	emergent trees overtopping thickets on termite mounds in seasonally-waterlogged grassland in the Zanzibar-Inhambane region	x	C	C
Margaritaria discoidea			x	f
Markhamia obtusifolia			x	f
Markhamia zanzibarica		x	C	f
Maytenus senegalensis			x	f
Olea europaea	(*Olea europaea* ssp. *cuspidata* , synonym: *Olea africana*)		x	f
Oncoba spinosa			x	
Oxytenanthera abyssinica	(lowland bamboo species indigenous to Africa)		x	
Parinari curatellifolia			C	f
Peltophorum africanum	widespread species in Zambezian termite-mound thicket		C	f
Phoenix reclinata	(palm species)		x	f

SPECIES	Regional status	Malawi	Zambia	Coast
Phytolacca dodecandra			x	
Piliostigma thonningii			x	f
Psydrax parviflora			x	
Pterocarpus angolensis			x	f
Rhoicissus tridentata	widespread species in Zambezian termite-mound thicket		x	f
Rhus tenuinervis			x	
Schinziophyton rautanenii			x	
Senna singueana			x	f
Sideroxylon inerme	thickets on termite mounds in seasonally-waterlogged grassland in the Zanzibar-Inhambane region		x	C
Steganotaenia araliacea	widespread species in Zambezian termite-mound thicket		x	
Sterculia africana			C	f
Sterculia quinqueloba		x	x	f
Strychnos lucens			x	
Strychnos potatorum	widespread species in Zambezian termite-mound thicket		C	
Syzygium cordatum			C	f
Syzygium guineense			C	f
Tamarindus indica	emergent trees overtopping thickets on termite mounds in seasonally-waterlogged grassland in the Zanzibar-Inhambane region	x	x	C
Thespesia garckeana			C	
Uapaca kirkiana			x	
Uapaca nitida			x	f
Uapaca sansibarica			x	f
Vitex doniana			x	f
Ximenia americana			x	f
Zanthoxylum chalybeum			x	f
Ziziphus mucronata		x	C	f

28. Afroalpine vegetation (A)

28.1. Description

The vegetation of the highest mountains of tropical Africa (≥ 3800, including the Aberdares [Kenya], Mt. Elgon [Kenya and Uganda], Mt. Kenya, Mt. Kilimanjaro [Tanzania], Mt. Meru [Tanzania], the Ruwenzori Mts. [Uganda and DRC], the Virunga Mts. [Rwanda and DRC] and the higher peaks of Ethiopia [but see section 3.2]) are characterized by the occurrence of Giant *Senecio* species (up to 6 m; *Senecio* subgenus *Dendrosenecio*), Giant *Lobelia* species (up to 6 m), shrubby *Alchemilla* species and other plants of remarkable lifeforms. Since most of the species also occur in the montane Ericaceous (E, see Volume 3) and Afromontane forest belts (Fa, Fb and Fd, see Volume 2), Afroalpine vegetation can be regarded as an archipelago-like floristic region of extreme floristic impoverishment (White 1983 p. 169).

Afroalpine vegetation occurs on high mountains where night frosts are liable to occur throughout the year (White 1983 p. 46).

Knox and Palmer (1993, Fig 3) provide the following distribution pattern of the 11 species of giant *Senecio* species[18]:

- *Senecio* subgenus *Dendrosenecio adnivalis*: Ruwenzori Mts.
- *Senecio* subgenus *Dendrosenecio battiscombe*i: Aberdares and Mt. Kenya
- *Senecio* subgenus *Dendrosenecio brassiciformis*: Aberdares
- *Senecio* subgenus *Dendrosenecio cheranganiensis*: Cherangani Hills
- *Senecio* subgenus *Dendrosenecio elgonensis*: Mt. Elgon
- *Senecio* subgenus *Dendrosenecio erici-rosenii*: Ruwenzori,Virunga and Mitumba Mts.
- *Senecio* subgenus *Dendrosenecio johnstonii*: Mt. Kilimanjaro
- *Senecio* subgenus *Dendrosenecio keniensis:* Mt. Kenya
- *Senecio* subgenus *Dendrosenecio keniodendron*: Aberdares and Mt. Kenya
- *Senecio* subgenus *Dendrosenecio kilimanjar*i: Mt. Kilimanjaro
- *Senecio* subgenus *Dendrosenecio meruensis*: Mt. Meru

18: Based on analysis of chloroplast DNA, these authors suggest that the Dendrosenecio subgenus originated on Mt. Kilimanjaro

Figure 28.1. Afroalpine vegetation in the foreground with rosettes of Lobelia rhynchopetalum (before flowering). In the background the montane Ericaceous belt (see Volume 2) on the slope of the valley with Erica arborea. Semien mountains (Ethiopia). Photograph by I. Friis and Sebsebe Demissew (October 2009). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 30A. 2010.

Figure 28.2. Mosaic of grass sward and Helichrysum crispinum heath together with flowering and sterile individuals of Lobelia rhynchopetalum. Bale mountains (Ethiopia). Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 30C. 2010.

Figure 28.3. Afroalpine vegetation in the Ruwenzori Mts (Uganda). Photograph by M. Namaganda (June 2008).

Figure 28.4. Afroalpine vegetation in the Ruwenzori Mts (Uganda). Photograph by M. Namaganda (June 2008).

Figure 28.5. Afroalpine vegetation on the Karisimbi Volcano (Rwandan side of the Virunga Mts.). Photograph by E. Fischer (October 1991).

Figure 28.6. Typical East African bird species that occur in Afroalpine vegetation within their natural habitat. Shell guide to East African birds (1960; reproduced with permission from URL *http://ufdc.ufl.edu/UF00077050*).

28.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 28. Species composition for Afroalpine vegetation (A)

SPECIES	Regional status	Ethiopia	Kenya	Rwanda	Tanzania	Uganda
Alchemilla argyrophylla	characteristic (genus)		x		f	x
Alchemilla elgonensis	characteristic (genus)		x			f
Alchemilla johnstonii	characteristic (genus)		x	x	f	x
Lobelia deckenii	characteristic (genus)					C
Lobelia rhynchopetalum	characteristic (genus)	C				
Lobelia stuhlmannii	characteristic (genus)			C		
Lobelia telekii	characteristic (genus)		C			C
Lobelia wollastonii	characteristic (genus)			C		C
Senecio myriocephalus	characteristic (genus)	x				
Senecio subgenus Dendrosenecio adnivalis	characteristic (genus)					C
Senecio subgenus Dendrosenecio elgonensis	characteristic (genus)		f			C
Senecio subgenus Dendrosenecio johnstonii	characteristic (genus)		C	C		f
Senecio subgenus Dendrosenecio keniodendron	characteristic (genus)		C			
Senecio subgenus Dendrosenecio kilimanjari	characteristic (genus)				C	
Senecio subsessilis	characteristic (genus)		f	C	f	f
Adenocarpus mannii		x	f	x	f	f
Erica arborea		C	x	f	f	f
Helichrysum formosissimum				x		C
Hypericum revolutum		C	f	f	f	f

29. Afromontane bamboo (B)

29.1. Description

Sinarundinaria alpina (synonym: *Arundinaria alpina*) is one of the four bamboo species (giant grasses with erect woody stems of 2 - 20 m [or even taller] that sometimes form pure and virtually impenetrable communities, and that persist for several years, then flower gregariously and then die back,) that are indigenous to Africa (the other species are *Oxytenanthera abyssinica* [mapped in the VECEA map as "L", see below], *Oreobambos buchwaldii* [it was recorded within species assemblages for various forest vegetation types] and *Arundinaria tessellata* [current name: *Thamnocalamus tessellatus*; it replaces *Sinarundinaria alpina* in South Africa]). *Sinarundinaria alpina* occurs on most of high mountains of East Africa (Ethiopia to southern Tanzania), but south of Tanzania it is only known to occur on the North Viphya Plateau (Malawi), Dedza Mt. (Malawi) and Mt. Mulanje (Malawi); White 1983 pp. 55 and 166). The Flora Zambesiaca confirms that *Sinarundinaria alpina* does not occur in Zambia. The species presently does not occur on the North Viphya Plateau (C. Dudley, personal observations).

In East Africa, *Sinarundinaria alpina* is mostly found between 2400 and 3000 m, although it ascends on Mt. Kenya to 3500 m and descends in the Uluguru Mts. (Tanzania) to 1630 m. It grows most vigorously on deep volcanic soils and gently slopes where the annual rainfall exceeds 1250 mm. The largest areas are found on the Aberdare Range (Kenya, 65000 ha), the Mau Range (Kenya, 51000 ha) and Mt Kenya (39000 ha; White 1983 p. 166). *Sinarundinaria alpina* does not form a belt on Mt. Kilimanjaro, whereas a bamboo belt occurs on the adjacent Mt. Meru (White 1983 p. 167).[19]

Hemp (2006) provides the following speculations about the absence of the bamboo zone on Mt. Kilimanjaro:

> "Another feature of the forests of Kilimanjaro is the absence of a bamboo zone, which occurs on all other tall mountains in East Africa with a similarly high rainfall. Observations on other East African mountains showed that the occurrence of bamboo is linked to a special type of disturbance: the activity of large herbivores. *Sinarundinaria alpina* stands are favoured by elephants and buffaloes. On Kilimanjaro these megaherbivores occur on the northern slopes, where it is too dry for a large bamboo zone to develop. They are excluded from the wet southern slope forests by topography and humans who have cultivated the foothills for at least 2000 years. From studies on Mt Kenya (Vanleeuwe and Lambrechts [1999]) it is known that elephants climb slopes only up to a steepness of about 30 degrees. On the south-western and north-eastern slopes of Kilimanjaro, very deep (up to several 100 m) and very steep (>30 degree) valleys exist, which reach high up into the alpine zone. These deep gorges prevent large herbivores migrating from the northern side of the mountain to the southern. Combined with human occupation of the wetter slopes, this

19: Friis *et al.* 2010 (p. 95) mention that Hedberg only recorded distinct mountain bamboo zones from the Aberdares, Mt. Elgon, Mt. Kenya, Mt. Meru, Ruwenzori Mts., and Virungu Mts.

means that the southern and south-eastern montane forests of Mt Kilimanjaro are no longer accessible for buffaloes and elephants. This interplay of biotic and abiotic factors could explain not only the lack of a bamboo zone on Kilimanjaro but also offers possible explanations for the patterns of diversity and endemism."

Various tree species occur scattered within the bamboo. These tree species probably became established when bamboo plants died following their gregarious flowering (White 1983 p. 167).

Figure 29.1. Afromontane bamboo (*Sinarundinaria alpina;* synonym: *Arundinaria alpina*) in Kabatwa (Volcanoes National Park, Rwanda). Photograph by V. Minani (October 2009).

Figure 29.2. Afromontane bamboo (*Sinarundinaria alpina*; synonym: *Arundinaria alpina*) on Mt. Elgon, Ugandan side. Photograph by E.Fischer (October 1997).

Figure 29.3. Edge of thicket of Afromontane bamboo (*Sinarundinaria alpina*; synonym: *Arundinaria alpina*) near Masha (Ethiopia). In the national reference for Ethiopia, Afromontane bamboo was not described separately from Afromontane forest types in which Afromontane bamboo occurs; this image was included with images for Afromontane rain forest (Fa). Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 25E. 2010.

Figure 29.4. Edge of thicket of Afromontane bamboo (*Sinarundinaria alpina*; synonym: *Arundinaria alpina*) after mass-flowering near Masha (Ethiopia). In the national reference for Ethiopia, Afromontane bamboo was not described separately from Afromontane forest types in which Afromontane bamboo occurs; this image was included with images for Afromontane rain forest (Fa). Photograph by I. Friis and Sebsebe Demissew (January 2009). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 25F. 2010.

29.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 29. Species composition for Afromontane bamboo (B)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda
Sinarundinaria alpina	dominant	f	D	f	D	D	D
Cornus volkensii	characteristic		C	f	f	C	f
Dombeya torrida	characteristic	f	x	f	f	C	C
Faurea saligna	characteristic		f	f	f	C	x
Hagenia abyssinica	characteristic	f	C	f	f	C	C
Ilex mitis	characteristic	f	f	f	x	C	C
Juniperus procera	characteristic	f	f	f		C	f
Lepidotrichilia volkensii	characteristic	f	C	f	f	C	x
Nuxia congesta	characteristic	f	x	f	f	C	x
Podocarpus latifolius	characteristic		x	f	f	C	C
Prunus africana	characteristic	f	f	f	f	C	f
Rapanea melanophloeos	characteristic	f	x	f	x	C	C
Tabernaemontana stapfiana	characteristic		f	f	f	C	f
Agauria salicifolia		f	x	f	x	f	x
Hypericum revolutum		f	C	f	f	f	x
Peddiea fischeri			x		f	f	x
Rhamnus prinoides		f	x	f	x	f	x
Rubus apetalus		f	x	f	f	f	x
Sambucus ebulus			x			f	f
Schefflera volkensii		f	C			f	f

30. Desert (D)

30.1. Description

White (1983) does not think that there is an objective criterion to separate arid regions from wet regions, although he also mentions that semi-desert areas usually begin to appear where the mean annual rainfall drops below 250 mm, the southern boundary of the Sahara desert corresponds to the 150 mm isohyet and the northern boundary of the Sahara desert corresponds to the 100 mm isohyet. However, he defines semi-deserts as areas where the differences in soil characteristics (such as soil colour) are more conspicuous than the vegetation itself, but where the plants are still sufficiently evenly distributed so that the vegetation can be further classified in physiognomic categories such as "semi-desert grassland" and "semi-desert shrubland" (White 1983 pp. 52 - 53). We therefore think that deserts can be defined as "areas where the differences in soil characteristics (such as soil colour) are more conspicuous than the vegetation itself and where the individual plants are never abundant enough in large enough areas to justify the classification of the vegetation as another physiognomic vegetation type such as grassland or shrubland" (see also White 1983 p. 53).

Areas in northern Kenya where annual rainfall is 150 mm are sometimes regarded as desert. Areas in the driest parts of northern Kenya where annual rainfall is higher than 150 mm and where extensive stone pavement areas are devoid of vegetation are **edaphic desert** areas. They are classified as edaphic vegetation since they occur in mosaic with semi-desert shrubland and dwarf bushland (White 1983 p. 53).

The Chalbi desert of Marsabit district (Kenya) is an edaphic desert that is part of a closed drainage basin. This desert has numerous springs that originate from subsurface flows originating from the surrounding mountains. The accumulation of salts after seasonal floodwaters have evaporated inhibit plant growth except very locally (White 1983 p. 120). The halophytic grass *Drake-brockmania somalensis* occurs near outlets of the major tributary streams; this vegetation type was classified as halophytic vegetation in the VECEA map (Z, see below).

Figure 30.1. Desert with tufts of the grass *Panicum turgidum*. These tufts collect wind-blown sand and may eventually develop into dunes. Northwest of Asaita (Ethiopia). Altitude approximately 400 m. Photograph by I. Friis and Sebsebe Demissew (October 2006). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 14B. 2010.

Figure 30.2. Barren land in Marsabit District (Kenya). Photograph by F. Gachathi (2009).

Figure 30.3. Floodplain of Habasweni (Kenya). Photograph by F. Gachathi (2009).

Figure 30.4. Afromontane "moss and lichen" desert on on summit of Mt. Karisimbi (Rwandan side of the Virunga Mts.). Photograph by E. Fischer (October 1991).

30.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 30. Species composition for Desert (D)

SPECIES	Regional status	Ethiopia	Kenya
Panicum turgidum (2009)	dominant grass species of Somalia-Masai semi-desert grassland	C	f
Aristida adscensionis	characteristic		C
Indigofera spinosa	characteristic		C
Barleria proxima			C
Blepharis linariifolia			C
Cenchrus pennisetiformis	(grass)		C
Gyrocarpus hababensis		C	f
Leptadenia pyrotechnica		C	
Leptothrium senegalense	(grass)		C
Tetrapogon cenchriformis	(grass)		C

31. Grassland (excluding semi-desert grassland and edaphic grassland, G)

31.1. Description

White (1983) attempted to distinguish between climatic, edaphic and secondary grasslands. However, he admitted that is was not always easy to decide to which category a particular grassland type should belong since various factors may operate together. For example, grasslands may occur in soils that are incapable of supporting trees, but the soils themselves may have developed under unusual climatic conditions (White 1983 p. 51). The occurrence of semi-desert grassland (S) seems to be under climatic and edaphic control - rather than classifying it as climatic grassland or edaphic grassland, we classified it separately within the VECEA map as mapping unit S (see below).

Much of the grasslands which were considered to be climatic grasslands by early explorers are in fact secondary as a result from fire. However, the statement that no tropical grassland would be a true climatic climax is probably also incorrect (White 1983 pp. 50 - 51).

31.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 31. Species composition for Grassland (excluding semi-desert grassland and edaphic grassland, G)

SPECIES Regional status	Kenya	Uganda
Acacia drepanolobium		x
Acacia mellifera		x
Barleria prionitis		x
Chrysopogon aucheri		x
Dichrostachys cinerea		x
Microchloa kunthii	x	
Pennisetum mezianum	x	x
Pennisetum sphacelatum	x	
Sporobolus helvolus	x	
Themeda triandra	x	
Trichoneura mollis	x	

32. Mangrove (M)

32.1. Description

Mangrove is dominated by trees that occur on shores that are periodically flooded by sea-water. Mangrove was classified by White (1983) as a major physiognomic type and not as a subtype of forests - especially since near climatic and edaphic limits of mangrove, many mangrove species form communities that physiognomically resemble bushland and thickets but are otherwise very similar to "mangrove forests". All true mangrove species either have pneumatophores which are exposed at low tide or are viviparous (or nearly so, most African species show both these features). The *Bruguiera, Ceriops* and *Rhiziphora* mangrove species are viviparous: the embryo develops precociously ('exceptionally early') after which the hypocotyl undergoes enormous development. Mangrove species have succulent leaves. Their roots are able to desalinate seawater to a high degree but some salts also accumulate in their tissues (only *Avicennia* species excrete salt from their leaves) (White 1983 pp. 54 - 55 and 261).

The true mangrove species that occur in East Africa include *Avicennia marina, Bruguiera gymnorhiza, Ceriops tagal, Heritiera littoralis, Lumnitzera racemosa, Rhizophora mucronata, Sonneratia alba, Xylocarpus granatum* and *Xylocarpus moluccensis*. All these species extend further to the east and most reach the western Pacific Ocean (White 1983 p. 261).

32.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Tabel 32. Species composition for Mangrove (M)

SPECIES	Regional status	VECEA
Avicennia marina	mangrove in East Africa	x
Bruguiera gymnorhiza	mangrove in East Africa	x
Ceriops tagal	mangrove in East Africa	x
Heritiera littoralis	mangrove in East Africa	x
Lumnitzera racemosa	mangrove in East Africa	x
Rhizophora mucronata	mangrove in East Africa	x
Sonneratia alba	mangrove in East Africa	x
Xylocarpus granatum	mangrove in East Africa	x
Xylocarpus moluccensis	mangrove in East Africa	x

Figure 32.1. Mangrove forest. Tanga region of Tanzania. Photograph by H. N. Moshi (May 2009).

Figure 32.2. Typical East African bird species from mangrove within their natural habitat. Shell guide to East African birds (1960; reproduced with permission from URL *http://ufdc.ufl.edu/UF00077050*).

33. Somalia-Masai semi-desert grassland and shrubland (S)

33.1. Description

White (1983) does not think that there is an objective criterion to separate arid regions from wet regions, although he also mentions that semi-desert areas usually begin to appear where the mean annual rainfall drops below 250 mm, the southern boundary of the Sahara desert corresponds to the 150 mm isohyet and the northern boundary of the Sahara desert corresponds to the 100 mm isohyet. However, he defines semi-deserts as areas where the differences in soil characteristics (such as soil colour) are more conspicuous than the vegetation itself, but where the plants are still sufficiently evenly distributed so that the vegetation can be further classified in physiognomic categories such as "semi-desert grassland" and "semi-desert shrubland" (White 1983 pp. 52 - 53, see also the description of desert [D] above).

Where annual rainfall is between 100 and 200 mm in the Somalia-Masai region, semi-desert grassland (dominated by *Centropodia glauca*, *Eragrostis mahrana* and *Panicum turgidum*) occurs on deep sand. Under similar rainfall conditions, semi-desert shrubland occurs on stony soils (White 1983 p. 115). Most primary shrubland areas in African lowlands occur under a semi-desert climate and where edaphic conditions influence the vegetation (such as Somalia-Masai shrubland occurring on gypseous soils [these soils are themselves also partially a result from the dry climate]; White (1983 p. 50). *Lagenantha cycloptera* is a gypsum-tolerant succulent species that forms almost pure stands (20% cover) on white calcareous soils in the old Chalbi lake bed in Marsabit district (White 1983 p. 120).

Semi-desert annual grassland is the most extensive vegetation type in Marsabit district (covering one third of the area, especially in the driest parts). The dominant grasses are *Aristida adscensionis* and *Aristida mutabilis*; during drought periods, these grasses may be absent for years. Woody plants are nearly always present (then providing 2 -20 percent ground cover), sometimes in the forms of shrubs (*Duosperma eremophilum*) or sometimes as bushes or bushy trees such as *Acacia horrida, Acacia reficiens, Acacia senegal, Acacia seyal, Acacia tortilis* and several *Commiphora* spp. (White 1983 p. 120).

Semi-desert dwarf shrubland (< 1 m high) is the second-most extensive vegetation type in Marsabit district (covering 28 percent of the area). *Duosperma eremophilum* and *Indigofera spinosa* dominate or co-dominate 71% and 64% percent of all dwarf shrubland respectively. The more moisture demanding *Duosperma eremophilum* occupies somewhat heavier and wetter soils, whereas *Indigofera spinosa* occupies the drier sites. When these species occur together, they often show a catenary relationship with *Indigofera* dominant on the compact soils of ridge tops and *Duosperma* dominant in shallow depressions (White 1983 p. 120). Extensive areas are without woody species, but bushes and small trees including *Acacia etbaica, Acacia mellifera, Acacia reficiens, Acacia senegal, Acacia seyal, Acacia tortilis, Boswellia neglecta* and various *Commiphora* species have a scattered occurrence with 2 to 20 percent cover (White 1983 p. 120).

Figure 33.1. Semi-desert grassland with the annual grass species *Aristida mutabilis.* Marsabit District (Kenya). Photograph by F. Gachathi (2009).

Figure 33.2. Semi-desert vegetation with the dwarf shrub *Indigofera spinosa*. *Acacia tortilis* occurs as a scattered emergent species. Turkana District (Kenya). Photograph by F. Gachathi (2010).

Figure 33.3. Semi-desert vegetation near Dolo Odo (Ethiopia). Photograph by T. Cole (2008, with permission from this author).

Figure 33.4. SD. Profile diagram of *Duosperma* (probably *D. eremophilum*) dwarf shrub grassland. The grass species is of the *Enneapogon* genus. Pratt *et al*. (1966, Fig 6a). Image obtained from URL: *http://www.jstor.org/stable/2401259*.

33.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 33. Species composition for Somalia-Masai semi-desert grassland and shrubland (S)

SPECIES	Regional status	Ethiopia	Kenya
Acacia etbaica	characteristic	f	f
Acacia horrida	characteristic	f	f
Acacia mellifera	characteristic	f	f
Acacia reficiens	characteristic	f	f
Acacia senegal	characteristic	x	x
Acacia seyal	characteristic	f	x
Acacia tortilis	characteristic	x	x
Aerva javanica	characteristic		f
Aloe breviscapa	characteristic		f
Aloe rigens	characteristic	f	f
Aloe scobinifolia	characteristic		f
Aristida mutabilis	characteristic		x
Caralluma edithae	characteristic (one of the two species that form most of the phytomass of communities of dwarf succulents)		f
Caralluma penicillata	characteristic (one of the two species that form most of the phytomass of communities of dwarf succulents)		f
Centropodia glauca	characteristic		f
Chrysopogon plumulosus	characteristic (grass species that was possibly dominant before overgrazing)		x
Duosperma eremophilum	characteristic		C
Eragrostis mahrana	characteristic		f
Euphorbia columnaris	characteristic (gypseous soils)		f
Euphorbia cuneata	characteristic	x	x
Euphorbia mosaica	characteristic (gypseous soils)		f
Euphorbia multiclava	characteristic		f
Euphorbia sepulta	characteristic (gypseous soils)		f
Farsetia longisiliqua	characteristic		f
Helichrysum glumaceum	characteristic		f
Indigofera spinosa	characteristic		C
Ipomoea sultani	characteristic		f
Jatropha pelargoniifolia	characteristic		f
Kelleronia splendens	characteristic	x	f
Leucas abyssinica	characteristic	f	f
Lycium europaeum	characteristic		f
Melocarpum hildebrandtii	characteristic	x	f
Ochradenus baccatus	characteristic	C	f
Panicum turgidum	characteristic	f	f
Pelargonium christophoranum	characteristic (gypseous soils)		f
Sporobolus spicatus	characteristic		f
Suaeda monoica	characteristic	x	f
Acacia bussei		x	f
Acacia drepanolobium		f	x
Acacia edgeworthii		x	f
Acacia ehrenbergiana		C	
Acacia gerrardii		f	x
Acacia nilotica		f	x
Acacia oerfota		x	f
Acacia zanzibarica		x	f
Adenium obesum		x	f
Aristida adscensionis			x
Balanites aegyptiaca		x	f
Balanites pedicellaris		x	f
Balanites rotundifolia		f	x
Blepharis linariifolia			x
Boscia angustifolia		x	f
Boscia coriacea		f	x
Boswellia rivae		x	f
Cadaba farinosa		f	x
Cadaba glandulosa		x	f
Cadaba mirabilis		x	x
Cadaba rotundifolia		x	f
Calotropis procera		x	f
Capparis cartilaginea		x	f
Capparis decidua		x	
Cenchrus pennisetiformis			x
Chasmanthera dependens		x	f
Cissus rotundifolia		x	f
Cocculus hirsutus		x	f
Combretum aculeatum		x	f
Commiphora africana		x	f
Commiphora erlangeriana		x	f
Commiphora erythraea		x	
Commiphora gileadensis		x	
Commiphora guidottii		x	f
Commiphora habessinica		x	f
Commiphora incisa		x	f
Commiphora kua		x	f

SPECIES	Regional status	Ethiopia	Kenya
Commiphora myrrha		x	f
Commiphora samharensis		C	f
Commiphora sphaerocarpa		x	f
Cordeauxia edulis		x	
Cordia sinensis		f	x
Cordia suckertii		x	
Cynanchum clavidens		x	
Cynanchum gerrardii		x	
Dactyloctenium aegyptium	(grass)		x
Delonix elata		x	f
Dobera glabra		x	f
Grewia similis		f	x
Grewia tenax		f	x
Hyphaene thebaica	(palm species)	x	
Indigofera oblongifolia		x	
Ipomoea donaldsonii		x	f
Lannea triphylla		x	f
Lawsonia inermis		x	f
Leptadenia arborea		x	
Leptadenia hastata		x	f
Leptothrium senegalense			x
Leucas tomentosa		x	f
Lycium shawii		x	f
Maerua crassifolia		f	x
Maerua oblongifolia		x	f
Momordica sessilifolia		x	f
Momordica spinosa		x	f
Moringa peregrina		x	
Oropetium capense			x
Salvadora persica		x	x
Sarcostemma viminale		x	f
Senna alexandrina		x	f
Senna longiracemosa		x	f
Senna sophera		x	
Sericocomopsis hildebrandtii		f	x
Sericocomopsis pallida		x	f
Sesamothamnus busseanus		x	f
Sesbania sesban		x	f
Sporobolus helvolus			x
Sporobolus pellucidus			x
Sterculia africana		x	f
Tamarindus indica		x	f
Tamarix aphylla		x	f
Tamarix nilotica		x	f
Terminalia brevipes		x	f
Tetrapogon cenchriformis			x
Tragus berteronianus			x
Vernonia cinerascens		x	f
Wrightia demartiniana		x	f
Ziziphus spina-christi		x	f

34. Fresh-water swamp (X)

34.1. Description

Permanent swamps occur in depressions where water permanently floods the surface to a shallow depth (seasonal swamps are usually covered with edaphic grassland [see g]). Most of the shallower lakes outside the Guineo-Congolian floristic region (especially those that are not strongly saline, see halophytic vegetation [Z]) have a wide belt of reed-swamp where the dominant species are usually rooted in the soil and have stems that rise out of the water (inside the Guineo-Congolian region, most swampy areas are covered with swamp forest [fs]). The most abundant reed-swamp species is *Cyperus papyrus* (a giant sedge species) but other species can also be dominant such as *Miscanthus violaceus*, *Phragmites australis* and *Phragmites mauritianus* grasses (White 1983 pp. 55 and 265).

True aquatic species occur in deeper water beyond the reed swamp and are either completely submerged or have floating leaves. A belt of floating grasses (principally *Vossia cuspidata, Paspalidium germinatum* and *Panicum repens*, but often invaded by *Cyperus papyrus*) frequently separates the reed-swamp from the aquatic vegetation (White 1983 p. 55).

Towards the landward margin of reed-swamp, often a narrow zone occurs of small trees and shrubs that are adapted to swamp conditions. The principal species are *Aeschynomene elaphroxylon, Aeschynomene pfundii, Ficus trichopoda* (scattered juveniles of swamp-forest trees), *Ficus verruculosa* (scattered juveniles of swamp-forest trees), *Kotschya africana, Mimosa pigra, Sesbania sesban* and *Syzygium cordatum* (scattered juveniles of swamp-forest trees; White 1983 p. 266).

Figure 34.1. Freshwater swamp in Morogoro District (Tanzania). Photograph by H. N. Moshi (2010).

Figure 34.2. Freshwater swamp dominated by *Cyperus papyrus* west of Mbale Town (Uganda). Photograph by J. Kalema (November 2010).

Figure 34.3. Freshwater swamp in Rwanda occurring at medium altitudes in that country in Akanyaru. Photograph by C. K. Ruffo (October 2009).

Figure 34.4. Typical East African birds of freshwater swamps and lakes within their natural habitat. Shell guide to East African birds (1960; reproduced with permission from URL *http://ufdc.ufl.edu/UF00077050*).

34.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 34. Species composition for Fresh-water swamp (X)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Acacia xanthophloea			x	x		f		
Aeschynomene abyssinica		x	x	f		f	f	f
Aeschynomene cristata		C	x	f		f	f	f
Aeschynomene elaphroxylon	trees on the landward margin of reed-swamp	C	x	x	f	f	f	f
Aeschynomene pfundii	trees on the landward margin of reed-swamp	C	x	x		f		f
Aeschynomene schimperi		C	x	f	f	f	f	f
Ceratophyllum demersum	submerged community in deeper water beyond the reed swamp		f	x		f	f	
Cissampelos mucronata		f	f		f	f	C	
Cyperus latifolius		f			C			
Cyperus papyrus	the main constituent of most of the shallower lakes (except those that are strongly saline) outside the Guineo-Congolian region (where swamp forests are more prominent); also in floating mats		C	x	C	C	C	C
Dissotis rotundifolia	principal associate of papyrus		f			f	C	
Echinochloa pyramidalis	species rooted in Vossia cuspidata mats (grass)		f	x		f	f	
Echinochloa stagnina	species rooted in Vossia cuspidata mats (grass)		f			f	f	C
Eichhornia crassipes	free-floating species, pest introduced from tropical America (the water hyacinth)	f	f	x		f		
Ficus verruculosa	juveniles of swamp-forest trees on the landward margin of reed-swamp		f	f	f	f	x	f
Heterotis canescens	associate of Miscanthus violaceus in shallower lakes in which papyrus is absent						C	
Hibiscus diversifolius	principal associate of papyrus	f	f	x	f	f	f	f
Ipomoea rubens			x	x		f	f	
Kotschya africana	trees on the landward margin of reed-swamp	f	x	x	f	f	f	f
Leersia hexandra	associate of Miscanthus violaceus in shallower lakes in which papyrus is absent (grass)	f	f	x		f	C	C
Lemna perpusilla	free-floating species		f	x		f	f	
Loudetia phragmitoides	in shallow water on the landward side of papyrus swamp (grass)		f			f	f	
Ludwigia leptocarpa	principal associate of papyrus			x				f
Ludwigia octovalvis	principal associate of papyrus		x	x				f
Ludwigia stolonifera	principal associate of papyrus			x				
Melanthera scandens	principal associate of papyrus		f			f	x	
Mikania capensis	principal associate of papyrus		f		f	f	x	
Miscanthus violaceus	in shallow water on the landward side of papyrus swamp; also forms a distinct zone in shallower water from which papyrus is absent (grass)						C	
Nymphaea lotus	community with floating leaves in deeper water beyond the reed swamp	f	f	x		f	f	
Nymphaea nouchali	community with floating leaves in deeper water beyond the reed swamp		f	x	C	f	f	
Oryza longistaminata	(grass)		f			f	f	C
Pennisetum macrourum	(grass)							C
Persicaria decipiens		f	f			f	C	
Phoenix reclinata	(palm species)	f	f	x	C	f	f	f
Phragmites mauritianus	common in silted areas and lakes of volcanic origin in East Africa (grass)		x	C		f	f	C
Pistia stratiotes	free-floating species	f		x				
Pycreus mundtii			f	x	C	f	f	
Sesbania bispinosa			x			f		
Sesbania sesban	trees on the landward margin of reed-swamp	C	x	x	f	f	f	f
Syzygium cordatum	juveniles of swamp-forest trees on the landward margin of reed-swamp		f	x	C	f	x	f
Typha domingensis			x	C		f	f	
Typha latifolia	locally replaces papyrus at higher altitudes		x				f	
Utricularia gibba	associate of Miscanthus violaceus in shallower lakes in which papyrus is absent		f	x		f	f	
Vallisneria spiralis	submerged community in deeper water beyond the reed swamp			x				
Vigna luteola	principal associate of papyrus		f	x		f	f	
Voacanga thouarsii			x	x			f	f
Vossia cuspidata	floating mat at the edge of reed-swamps, also pioneer of reed-swamp		f	x		f	f	

35. Halophytic vegetation (Z)

35.1. Description

Halophytes are a relatively small group of plant species that can grow on saline soils. The most typical halophytes absorb soluble salts (especially Sodium chloride) and tolerate high concentrations in the cell sap of their leaves. The vegetation on saline soils is dominated by halophytes and is physiognomically varied, including halophytic grassland, wooded grassland, shrubland and bushland (White 1983 pp. 55 and 266).

Saline soils are frequently found in arid and semi-arid regions where rainfall is insufficient to transport salts. The distribution of saline soils is also partially determined by geology as they can occur in wetter regions around springs that bring soluble salts to the surface (White 1983 p. 266). The halophytic grass *Drake-brockmania somalensis* occurs near outlets of the major tributary streams to the Chalbi desert (Kenya, this edaphic desert is seasonally flooded, White 1983 p. 120).

In parts of East Africa, salts that are derived from volcanic deposits rich in Sodium are deposited in lake basins and river valleys. As a consequence, halophytic vegetation occurs in most of the lake basins of the Eastern Rift (especially Lakes Bogoria [Kenya], Elementeita [Kenya], Eyasi [Tanzania], Nakuru [Kenya], Magadi, Manyara [Tanzania], Natron [Tanzania], Rukwa [Tanzania] and Turkana [Kenya]). Halophytic vegetation also occurs around Lake Mweru Wantipa (Zambia), a lake that also lies in a down-faulted depression with internal drainage (White 1983 pp. 266 - 267).

The halophytic vegetation in the Lake Rukwa basin (Tanzania) is chiefly grassland and can be subdivided in three zones: (i) the beach zone that marks the maximum extent of the lake has pure stands of 1 to 2 m tall Sporobolus robustus; (ii) the alkaline swamp is colonized by *Diplachne fusca* (current name: *Leptochloa fusca*; this grass species also dominates alkaline swamps south of Lake Eyasi [Tanzania]); and (iii) the alkaline flats (areas of the lake bed that are successively flooded or drying up) are colonized first by *Sporobolus spicatus* (a species that is also a chief plant around other lake basins in the Eastern Rift) but are replaced by *Odyssea jaegeri* when the lake shallowly refills (White 1983 p. 267).

Many of the flat valleys in the drier parts of Tanzania have alkaline soils. This is especially the case for the flood plains of the Pangani River as large amounts of salt are released from the volcanic deposits of Mt. Kilimanjaro and Mt. Meru. Prominent halophytes include *Salvadora persica*, *Suaeda monoica, Sporobolus robustus* and *Triplocephalum holstii*. Other species occur on the flood plain such as *Acacia xanthophloea* (a species that may not persist if high levels of sodium reach their rooting horizon [White 1983 p. 30]) and *Sesbania sesban* (White 1983 p. 267).

Figure 35.1. Salt pan surrounded by scrub of *Suaeda monoica* (Chenopodiaceae). The surrounding vegetation is desert (D) and semi-desert (S). Between Dichioto (Ethiopia) and the border with Djibouti. Approximate altitude 200 m. Photograph by I. Friis and Sebsebe Demissew (October 2006). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 35B. 2010.

Figure 35.2. Salt pan surrounded by scrub of *Suaeda monoica* (Chenopodiaceae). In the background lava flows without vegetation (desert [D]). Between Dichioto (Ethiopia) and the border with Djibouti. Approximate altitude 200 m. Photograph by I. Friis and Sebsebe Demissew (October 2006). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 35D. 2010.

Figure 35.3. A section of the Pangani floodplain not far from Hedaru with halophytic vegetation characterized by Suaeda monoica. Altitude approximately 650m. The Pare Mountains can be seen in the background. Photograph taken during the rainy season Photograph by H. N. Moshi (May 2009).

Figure 35.4. Detail of *Suaeda monoica*. Photograph in same location as previous photograph (Figure 11.3). Photograph by H. N. Moshi (May 2009).

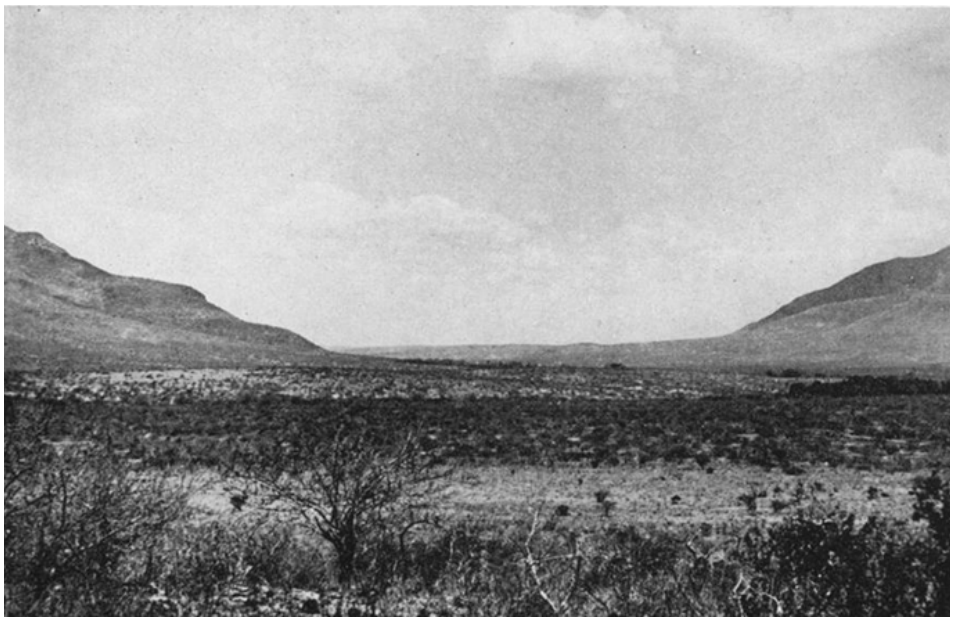

Figure 35.5. The original caption for this photograph was: semi-arid vegetation in the Mkomazi gap between the southern Pare and the west Usambara mountains (Tanzania; photograph by P. J. Greenway). Although this area was mapped by Gillman (1949) as "desert and semi-desert", we mapped it in the VECEA map as halophytic vegetation since we expect that most of these areas typically contain *Suaeda monoica* (salt bush; see also photographs 11.3 and 11.4 from the same general area). Gillman (1949, Fig 17). Image obtained from URL: *http://www.jstor.org/stable/211155*.

35.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 35. Species composition for halophytic vegetation (Z)

SPECIES	Regional status	Ethiopia	Kenya	ZIT (Tanzania subtype)	ZaT (Tanzania subtype)	Zambia
Cyperus laevigatus	chief plants around saline lakes in Kenya and Uganda		f	C	f	
Sporobolus spicatus	chief plants around saline lakes in Kenya and Uganda; alkaline flats around Lake Rukwa (grass)		C	C	f	C
Drake-brockmania somalensis	halophytic grass that grows near the outlets at the edge of the Chalbi desert		C			
Leptochloa fusca	alkaline swamp in the Lake Rukwa basin; Wembere depression south of Lake Eyasi (grass)		f	C	f	C
Psilolemma jaegeri	alkaline flats around Lake Rukwa (grass)					C
Salsola africana			C			
Salvadora persica	prominent halophyte in flood plain of the Pangani river	f	f	f	C	f
Sesbania sesban	flood plain of the Pangani river	f	x	f	C	f
Sporobolus robustus	beach zone on fringe of Lake Rukwa; prominent halophyte in the flood plain of the Pangani river (grass)				C	
Suaeda monoica	prominent halophyte in flood plain of the Pangani river; replaces *Acacia xanthophloea* when the water table rises; also in semi-desert dwarf shrubland	C	C	f	C	
Triplocephalum holstii	prominent halophyte in flood plain of the Pangani river		f	f	C	

36. Edaphic grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, g)

36.1. Description

White (1983)did not strictly apply a differentiation between edaphic wooded grassland (with cover percentages of 10 - 40% woody species) and edaphic grassland (with cover percentages of <10% woody species) since both types intergrade and edaphic wooded grasslands are often difficult to delimit from the more open grasslands with which they are associated (White 1983 pp. 50 - 52). **Within the VECEA map, we loosely[20] defined "edaphic wooded grassland" as "edaphic grassland with scattered woody species" and "edaphic grassland" as "edaphic grassland without scattered woody species". This means that some vegetation types that would have been classified as "edaphic grasslands" in a strict physiognomic classification system (*i.e.* woody cover < 10%) may have been allocated to "edaphic wooded grasslands".**

The most widespread edaphic grasslands are those associated with seasonally or permanently waterlogged soils. They are limited in areas with short or no dry seasons (such as the Guineo-Congolian floristic region), but are widespread in regions which experience strongly seasonal rainfall (such as the Indian Ocean coastal belt and the Somalia-Masai, Sudanian and Zambezian floristic regions). Waterlogged soils usually occur in depressions which receive more water than is supplied by incident rainfall, but sometimes parent material has an overriding effect such as on edaphic grasslands that occur on volcanic soils (mapped as a distinct VECEA subtype [gv]; White 1983 p. 51). Alkaline grasslands that occur in basins are considered to be halophytic vegetation (mapped separately in VECEA as Z; White 1983 p. 100).

Although White (1983) described edaphic grasslands and wooded grasslands separately for the various floristic regions, we did not apply a floristic classification system to edaphic grasslands and edaphic wooded grasslands in the VECEA map.

Zambezian edaphic grassland[21] is widespread and occurs principally in four habitats: (i) seasonally waterlogged depressions on the Central African Plateau that are covered with edaphic grassland ("dambos"); (ii) flood plains of rivers and basins with internal drainage; (iii) Kalahari Sand of low relief; and (iv) sandy edges of dambos (White 1983 pp. 99 - 101):

Dambo grassland occurs above 1200 m and where there is seasonal flooding (some parts remain boggy throughout the year). The vegetation is usually a medium-dense grass mat of rather uniform appearance and height (50 to 100 cm with flowering culms of 1 to 2 m). *Loudetia simplex* is the most characteristic grass species and is dominant over large areas (White 1983 pp. 99 - 100).

20: among the exceptions that we made to the general rule, we did not include suffrutex grassland among wooded grassland types and neither did we include edaphic grassland on volcanic soils (gv) among wooded grassland types (although scattered *Acacia mellifera* may occur).

21: edaphic grasslands were studied in detail in several places because swarms of red locusts (*Nomadacris septemfasciata)* only originate from certain edaphic grassland areas. Four recognized major outbreak areas of the red locust are the Mweru-wa-Ntipa depression in Zambia and the Rukwa valley, the Malagarasi drainage basin and the Wembere depression in Tanzania (Vesey-Fitzgerald 1963).

Flood-plain grassland occurs in the valleys of larger rivers where erosion has covered the valley floors with alluvium (mostly heavy clay) and where seasonal rainfall results in seasonal waterlogging. These valleys are covered with a complex and constantly changing mosaic of edaphic grassland, permanent swamp vegetation (X) and termite-mound thickets ("bush groups", see termitary vegetation [T]), which makes it very difficult to impossible to map these types separately. Floodplain grasslands can be subdivided into wetter types and better-drained types. The most extensive areas of floodplain grasslands of the Zambezian region occur in the Lake Chilwa basin of Malawi, the Malagarasi and Rukwa valleys of Tanzania, the Bangweulu and Mweru Wantipa basins of Zambia and the Chambeshi, Kafue and Upper Zambezi valleys of Zambia (White 1983 p. 100).

Kalahari suffrutex grassland is a short wiry grassland that occurs on oligotrophic Kalahari Sand that is seasonally waterlogged. Trees are virtually absent and have been replaced by rhizomatous geoxylic suffrutices that are usually less than 0.6 m tall. At least under the present conditions, their stems are burnt back to ground level every year. The underground parts are usually of massive proportions and greatly exceed the phytomass of grasses, so these communities can be described as "underground forests" although above-ground they look like grasslands most of the year. Most of the suffrutex species are closely related to forest or woodland tree or liana species. The most abundant suffrutex is *Parinari capensis* and the most widespread dominant grasses are *Loudetia simplex* and *Monocymbium ceresiiforme* (White 1983 pp. 100 - 101). Widely distributed suffrutices described by Fanshawe (1971 p. 45) to occur in catenary regression stages of Kalahari woodlands include *Annona stenophylla, Chamaeclitandra henriqesiana, Diospyros chamaethamnus, Diospyros virgata, Gardenia brachythamnus, Lannea edulis, Leptactina benguelensis, Napoleonaea gossweilleri,* Parinari capensis, *Pygmaeothamnus zeyheri, Strobilanthopsis linifolia* and *Strychnos gossweileri.*

Most of the dambos are fringed by a narrow zone of sparse wiry grassland with abundant geoxylic suffrutices that are similar to Kalahari suffrutex grassland (White 1983 pp. 100 - 101). Fanshawe (1971 p. 52) describes suffrutex wooded grassland that occurs within a catenary sequence from Undifferentiated woodland (Wn) to grassland. Common suffrutices include *Annona stenophylla, Astripomoea malvacea, Brackenridgea arenaria*, *Combretum platypetalum, Cryptosepalum maraviense, Duosperma crenatum, Eriosema englerianum, Fadogia homblei, Gnidia kraussiana, Hibiscus rhodanthus, Ipomoea vernalis, Lannea edulis, Litogyne gariepina,* Parinari capensis and *Pygmaeothamnus zeyheri.*

Edaphic grassland in the Somalia-Masai floristic region was classified as edaphic wooded grassland, although treeless plains dominated by *Chrysopogon plumulosus* were described to occur in Somalia within deciduous bushland (Bd) and water-receiving depressions with black and cracking clays in Central Tanzania are treeless (but they are separated by an ecotone of wooded grassland, however; see edaphic wooded grassland [we]; White 1983 p. 116). Edaphic grassland that occurs on volcanic soils is mapped and described as a distinct subtype (mapping unit gv; see below).

Figure 36.1. Edaphic grassland in Amboseli National Park (Kenya). Photograph by F. Gachathi (2008).

Figure 36.2. A typical dambo near Mbala (Zambia) with its centre of open grassland and fringe of small trees. In the background, Miombo woodland (Wm) with *Brachystegia microphylla* (a species virtually confined to rocky hills and escarpments, White 1983 p. 93). Burtt *et al.* (1942 p. 79) comment that "a dambo often gives the impression of a wide road through the general monotony of the *Brachystegia* forest" (i.e. miombo woodland [Wm]). Burtt *et al*. (1942, Photograph 7). Image obtained from URL: *http://www.jstor.org/stable/2256690*.

Figure 36.3. The "rain pond catena" in Tanzania was classified by the VECEA project as a catena of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bdd) / edaphic grassland on drainage-impeded or seasonally flooded soils (g). Although the water-receiving depressions are typically treeless grasslands, usually they are separated from deciduous bushland (Bd) by an ecotone of wooded grassland that is dominated by gall *Acacias* (especially *A. drepanolium, A. seyal, A. malacocephala* and *A. pseudofistula*; White 1983 p. 116; see also Gillman 1949 p. 29). Gillman (1949, Fig 30; this is one of the photographs that was cited by White (1983 p. 116) for Somalia-Masai edaphic grassland).

Edaphic grassland that occurs on volcanic soils is mapped and described as a distinct subtype (mapping unit gv; see below).

Edaphic grassland of the Zanzibar-Inhambane region was described as a edaphic wooded grassland (we) since woody trees occur (although widely scattered; these areas also contain thicket-covered termite mounts [mapping unit T]; White 1983 p. 189).

In most Sudanian edaphic grasslands there is an admixture of woody plants (White 1983 p. 107). Edaphic grasslands were not described by White (1983) for the Afromontane floristic region, although he stated that "there are undoubtedly small areas of edaphic grassland" (White 1983 p. 168). No mention is made of edaphic grasslands for the Lake Victoria regional mosaic.

36.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 36. Edaphic grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, g)

SPECIES	Regional status	Kenya	Malawi	gdT (Tanzania subtype)	gfT (Tanzania subtype)	gbU (Uganda subtype)	geU (Uganda subtype)	gsU (Uganda subtype)	Zambia
Acroceras macrum	Zambezian edaphic grassland (wetter types of floodplain grasslands)	f		f	C	f	f	f	x
Andropogon brazzae	Zambezian edaphic grassland (better-drained types of floodplain grasslands)			f	C				
Andropogon schirensis	Zambezian edaphic grassland (dambo grasslands, suffrutex grasslands)	f		C	f	f	f	f	x
Aristida adscensionis	Somalia-Masai edaphic grassland (clays plains in Somalia)	x							
Aristida stipitata	Zambezian edaphic grassland (suffrutex grasslands)								x
Bothriochloa bladhii	(grass)	f	x	f	f	f	f	f	x
Brachiaria brizantha	(grass)	f	x	f	f	f	f	f	x
Brachiaria humidicola	(grass)	f	x	f	f				x
Brachiaria jubata	(grass)					C	f	f	
Chloris gayana	edaphic grasslands of the Serengeti plains	f	x	f	f	f	f	f	x
Cynodon dactylon	Somalia-Masai edaphic grasslands; edaphic grasslands of the Serengeti plains	x	x	f	f	f	f	f	x
Cyperus dives	(sedge)	f		f	f	f	C	f	
Cyperus latifolius	(sedge)					f	C	f	
Cyperus longus	(sedge)	f	C	f	f	f	f	f	
Dichanthium annulatum	(grass)	f	x	f	f				x
Echinochloa haploclada	(grass)	x	f	f	f	f	f	f	x
Echinochloa pyramidalis	Zambezian edaphic grassland (wetter types of floodplain grasslands)	f	x	f	C	f	C	f	x
Echinochloa stagnina	Zambezian edaphic grassland (wetter types of floodplain grasslands)	f		f	C	f	f	f	x
Entolasia imbricata	Zambezian edaphic grassland (better-drained types of floodplain grasslands)	f	x	f	C	f	f	f	x
Eragrostis atrovirens	(grass)	f	x	f	f				x
Erianthus teretifolius	Zambezian edaphic grassland (dambo grasslands)			C	f				
Eustachys paspaloides	edaphic grasslands of the Serengeti plains	f		f	f	f	f	f	x
Fimbristylis dichotoma	(sedge)					f	f	C	
Hyparrhenia bracteata	Zambezian edaphic grassland (dambo grasslands)	f	x	C	f	f	f	f	x
Hyparrhenia diplandra	Zambezian edaphic grassland (dambo grasslands)	f		C	f	f	f	f	x
Hyparrhenia filipendula	(grass)	f	x	f	f	C	f	f	x
Hyparrhenia newtonii	Zambezian edaphic grassland (dambo grasslands)			C	f	f	f	f	x
Hyparrhenia nyassae	(grass)	f	x	f	f	f	f	f	x
Hyparrhenia rufa	(grass)	f	x	f	f	f	f	C	x
Imperata cylindrica	(grass)	f	x	f	f	f	f	f	x
Leersia hexandra	Zambezian edaphic grassland (wetter types of floodplain grasslands)	f	x	f	C	f	C	f	x
Loudetia kagerensis	(grass)	f		f	f	f	f	C	
Loudetia simplex	Zambezian edaphic grassland (dambo grasslands, better-drained types of floodplain grasslands, suffrutex grassland)	f	x	C	C	f	f	f	x
Microchloa kunthii	edaphic grasslands of the Serengeti plains	f		f	f	f	f	f	
Monocymbium ceresiiforme	Zambezian edaphic grassland (dambo grasslands, better-drained types of floodplain grasslands, suffrutex grassland)		x	C	C				x

37. Edaphic grassland on volcanic soils (edaphic subtype, gv)

37.1. Description

The grasslands of the Serengeti Plains grow on soils that are derived from volcanic ash. Outside the greater Serengeti region, grasslands occurring on volcanic ash are very restricted in Africa (White 1983 pp. 125 and 126). Huge quantities of fine whitish-grey ash were produced by eruptions around 150,000 years ago by the now extinct Kerimasi volcano (2 52' S, 35 56' E). The ashes fell over a wide area where it resulted in a relatively flat surface over a formerly undulating peneplain. The ash hardened to form grey and light-brown calcareous tuffs and almost continuous layers of calcitic hard-pan layers at successive layers (with the accumulation of lime through downward leaching; White 1983 p. 126).

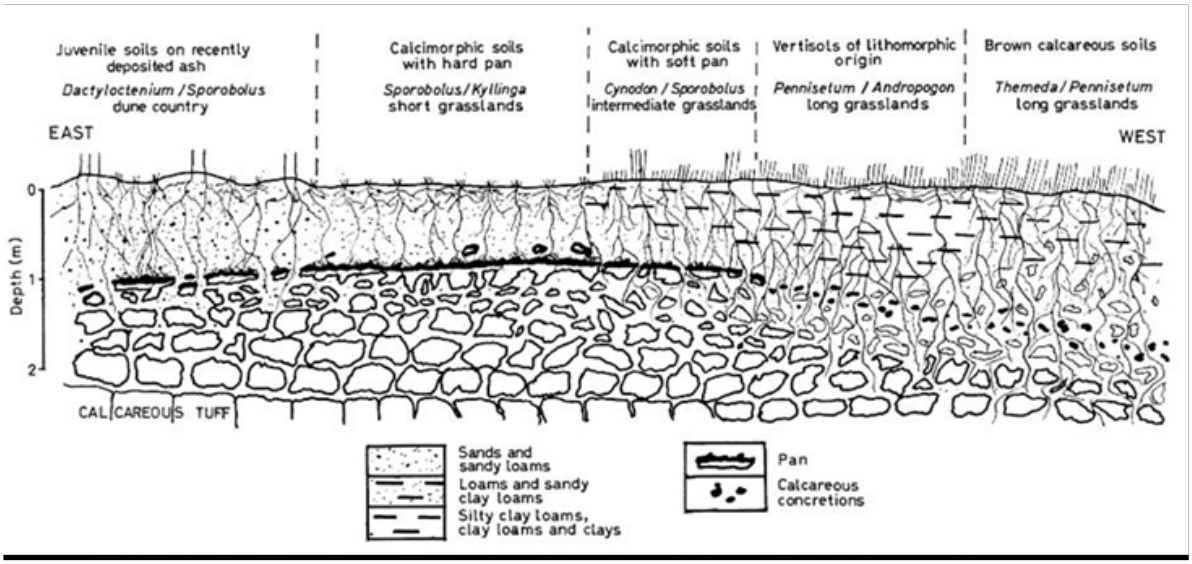

Figure 37.1. Profile diagram of the soil – edaphic grassland associations running east to west across the Serengeti Plains. Surface topography is not drawn to scale. White (1983 p. 126) describes that the gradient from the juvenile ash soils in the east to the more mature brown calcareous soils in the west are paralleled by a climatic gradient as annual rainfall gradually increases from the 380 mm in the east to 780 mm in the west. Anderson and Talbot (1965, Figure 2). Image obtained from URL: *http://www.jstor.org/stable/2257564*

Figure 37.2. Edaphic grassland on volcanic soils along the Namanga – Arusha road (Tanzania). Altitude approximately 1700 m. Photograph by H. N. Moshi (2009).

37.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 37. Species composition for Edaphic grassland on volcanic soils (edaphic subtype, gv)

SPECIES	Regional status	gvK (Kenya)	gvT (Tanzania)
Acacia mellifera	scattered bushes that sometimes occur on more stable areas between the dunes on juvenile soils on volcanic ash in the Serengeti plains		x
Andropogon greenwayi	edaphic grasslands of the Serengeti plains		C
Aristida adscensionis	Somalia-Masai edaphic grassland	x	
Aristida mutabilis		x	
Chloris gayana	edaphic grasslands of the Serengeti plains		C
Cynodon dactylon	edaphic grasslands of the Serengeti plains		C
Digitaria macroblephara	edaphic grasslands of the Serengeti plains		C
Enteropogon macrostachyus	(grass)	x	
Eragrostis superba	(grass)	x	
Eragrostis tenuifolia	edaphic grasslands of the Serengeti plains		C
Eustachys paspaloides	edaphic grasslands of the Serengeti plains		C
Heteropogon contortus	(grass)	x	
Indigofera spinosa		x	
Microchloa kunthii	edaphic grasslands of the Serengeti plains		C
Panicum coloratum	edaphic grasslands of the Serengeti plains		C
Pennisetum mezianum	edaphic grasslands of the Serengeti plains		C
Pennisetum stramineum	edaphic grasslands of the Serengeti plains		C
Sporobolus ioclados	edaphic grasslands of the Serengeti plains		C
Sporobolus spicatus		x	
Themeda triandra	edaphic grasslands of the Serengeti plains		C

38. Vegetation of sands (edaphic type, s)

38.1. Description

This vegetation type was not described in “the vegetation of Africa”.

38.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 38. Species composition for Vegetation of sands (edaphic type, s)

SPECIES Regional status	sM (Malawi)	sC (Coast)
Cadaba farinosa		x
Flacourtia indica	f	x
Garcinia livingstonei	f	x
Pandanus kirkii		f
Parinari curatellifolia	C	f
Salvadora persica	f	x
Sterculia africana	f	x
Terminalia sericea	C	

39. References

Austin, M.P. 2005.
Vegetation and the environment: discontinuities and continuities. Pages 52-84 in van der Maarel (ed.). 2005. Vegetation ecology. Blackwell Publishing, Oxford, UK.

Bailey, R.G. 2005.
Identifying Ecoregion Boundaries. Environmental Management Vol. 34, Suppl. 1: 14–26.

Bond, W.J., Woodward, F.I. & Midgley, G.F. 2005.
The Global Distribution of Ecosystems in a World without Fire. New Phytologist 165 (2): 525-537.

Burgess, N., D'Amico Hales, J., Underwood, E., Dinerstein, E. 2004.
Terrestrial Ecoregions of Africa and Madagascar: A Conservation Assessment. World Wildlife Fund Ecoregion Assessments, Island Press, Washington D, U.S.A.

Cadenasso, L.J., Pickett, S.T.A., Weathers, K.C., Bell, S.S., Benning, T.L., Carreiro, M.M. Todd & Dawson, E. 2003.
An Interdisciplinary and Synthetic Approach to Ecological Boundaries. BioScience 53 (8): 717-722.

Chazdon, R.L. 2008.
Chance and determinism in tropical forest succession. Pages 385-408. In Carson, W.P. & Schnitzer, S.A. 2008. Tropical Forest Community Ecology. Blackwell Publishing, Oxford, UK.

CSA, 1956.
C.S.A. Specialist meeting on Phytogeography. Yangambi 28th July-8th August 1956. Publication No. 22. Scientific Council for Africa South of the Sahara/Conseil Scientifique pour l'Afrique au Sud de Sahara. London, UK.

Dublin, Holly T., Sinclair, A.R.E., & McGlade, J. 1990.
Elephants and Fire as Causes of Multiple Stable States in the Serengeti-Mara Woodlands. The Journal of Animal Ecology, Vol. 59 (3): 1147-1164.

Friis, I., Sesebe Demissew, & Van Breugel, P. 2010.
Atlas of the potential Vegetation of Ethiopia. *Biologiske Skrifter (Biol.Skr. Dan.Vid.Selsk.)* 58: 307.

Friis, I. 1998.
Frank White and the development of African Chorology. Pages 25-51 in Huxley, C.R., Lock, J.M. & Cutler, D.F. (eds.). 1998. Chorology, Taxonomy and Ecology of the Floras of Africa and Madagascar. Royal Botanic Gardens, Kew, UK.

Greenway, P.J. 1973.
A classification of the vegetation of East Africa. Kirkia 9: 1-68.

Hubbell, S.P. 2008.
Approaching ecological complexity from the perspective of symmetric neutral theory.

Keay, R.W.J. 1959.
Vegetation map south of the Tropic of Cancer. Explanatory notes. With French translation by A. Aubréville. Oxford University Press

Langdale-Brown, I., Osmaston, H.A., & Wilson, J.G. 1964.
The vegetation of Uganda and its bearing on land-use. pp. 157 + maps (scale 1:500,000): vegetation (4 sheets), current land use, range resources, ecological zones, rainfall. Government of Uganda, Kampala.
McNaughton, S.J., Ruess, R.W. & Seagle, S.W. 1988.
Large Mammals and Process Dynamics in African Ecosystems. BioScience 38 (11): 794- 800.
Oldemann, B.A.A. 1978.
Architecture and energy exchange of dicotyledoneous trees in the forest. Pages 535-560 in Tomlinson, P.B. & Zimmermannn 1978. Tropical trees as living systems. Cambridge University Press, Cambridge, UK.
Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C., D'Amico, J.A., Itoua, I., Strand, H.E., Morrison, J.C., Loucks, C.J., Allnutt, T.F., Ricketts, T.H., Kura, Y., Lamoreux, J.F., Wettengel, W.W., Hedao, P. & Kasssem, K.R. 2001.
Terrestrial Ecoregions of the World: A New Map of Life on Earth. *BioScience* 51: 933-938.
Owen-Smith, N. 1987.
Pleistocene Extinctions: The Pivotal Role of Megaherbivores. Paleobiology 13 (3): 351-362.
Pennington, R.T., Cronk, Q.C.B. & Richardson, J.A. 2004.
Introduction and synthesis: plant phylogeny and the origin of major biomes. Phil. Trans. R. Soc. Lond. B 359: 1455-1464.
Pratt, D.J., Greenway, P.J. & Gwynne, M.D. 1966.
A Classification of East African Rangeland, with an Appendix on Terminology. The Journal of Applied Ecology 3 (2): 369-382
Sinclair, A.R.E., Mduma, S.A.R., Grant, J., Hopcraft, C., Fryxell, J.M., Hilborn, R. & Thirgood, S. 2007.
Long-Term Ecosystem Dynamics in the Serengeti: Lessons for Conservation. Conservation Biology Volume 21, No. 3, 580–590.
Tüxen, R. (1956)
Die heutige potentielle natürliche Vegetation als Gegenstand der Vegetationskartierung. Angewandte Pflanzensoziologie 13: 5–55.
van der Maarel, E. 1996.
Pattern and Process in the Plant Community: Fifty Years after A.S. Watt. Journal of Vegetation Science 7 (1): 19-28
van der Maarel, E. 2005.
Vegetation ecology - an overview. Pages 1-51 in van der Maarel), Vegetation ecology (ed). Blackwell Publishing, Oxford, UK.
Walker, L.R. and Del Moral, R. 2003.
Primary succession and Ecosystem rehabilitation. Cambridge University Press. Cambridge, UK.
White, F. 1970.
Classification. Page 78-112 in Chapman, J.D. and White, F. 1970. The evergreen forests of Malawi. Commonwealth Forestry Institute. University of Oxford. Oxford, UK.
White, F. 1976.
The vegetation map of Africa – The history of a completed project. Boissiera 24: 659-666-

White, F. 1993.

The AETFAT Chorological Classification of Africa: History, Methods and Applications. Bulletin du Jardin botanique national de Belgique 62 (1/4): 225-281 White, F. 1983. *The vegetation of Africa*. UNESCO, Paris, France.

Whitlow, R. 1984.

The study of vegetation in Africa: a historical review of problems and progress. Singapore Journal of Tropical Geography 5 (1): 88-101.

Whitlow, R. 1985.

Vegetation mapping in Africa: a critique. Singapore Journal of Tropical Geography 6 (1): 64-77.

Whitmore, T.C. 1982.

On pattern and process in forests. Pages 45-59 in E. I. Newman (ed.). The plant community as a working mechanism. Blackwell Scientific, Oxford, UK.

Whittaker, R.H. 1962.

Classification of Natural Communities. Botanical Review 28 (1): 1-239.

Whittaker, R.H. 1980.

Approaches to classifying vegetation. Pages 3-30 in Whittaker, R.H (ed.). 1980. Classification of Plant Communities (Handbook of Vegetation Science). Springer Verlag. New York, U.S.A.

Whittaker, R.J., Araújo, M.B., Jepson, P., Ladle, R.J., Watson, J.E.M, and Willis, K.J. 2005.

Conservation Biogeography: assessment and prospect. Diversity and Distributions 11: 3–23.

Young, A. 2007.

Thin on the Ground: Land Resource Survey in British Overseas Territories. The Memoir Club, Stanhope, UK.